Status of the AIRS-RTA

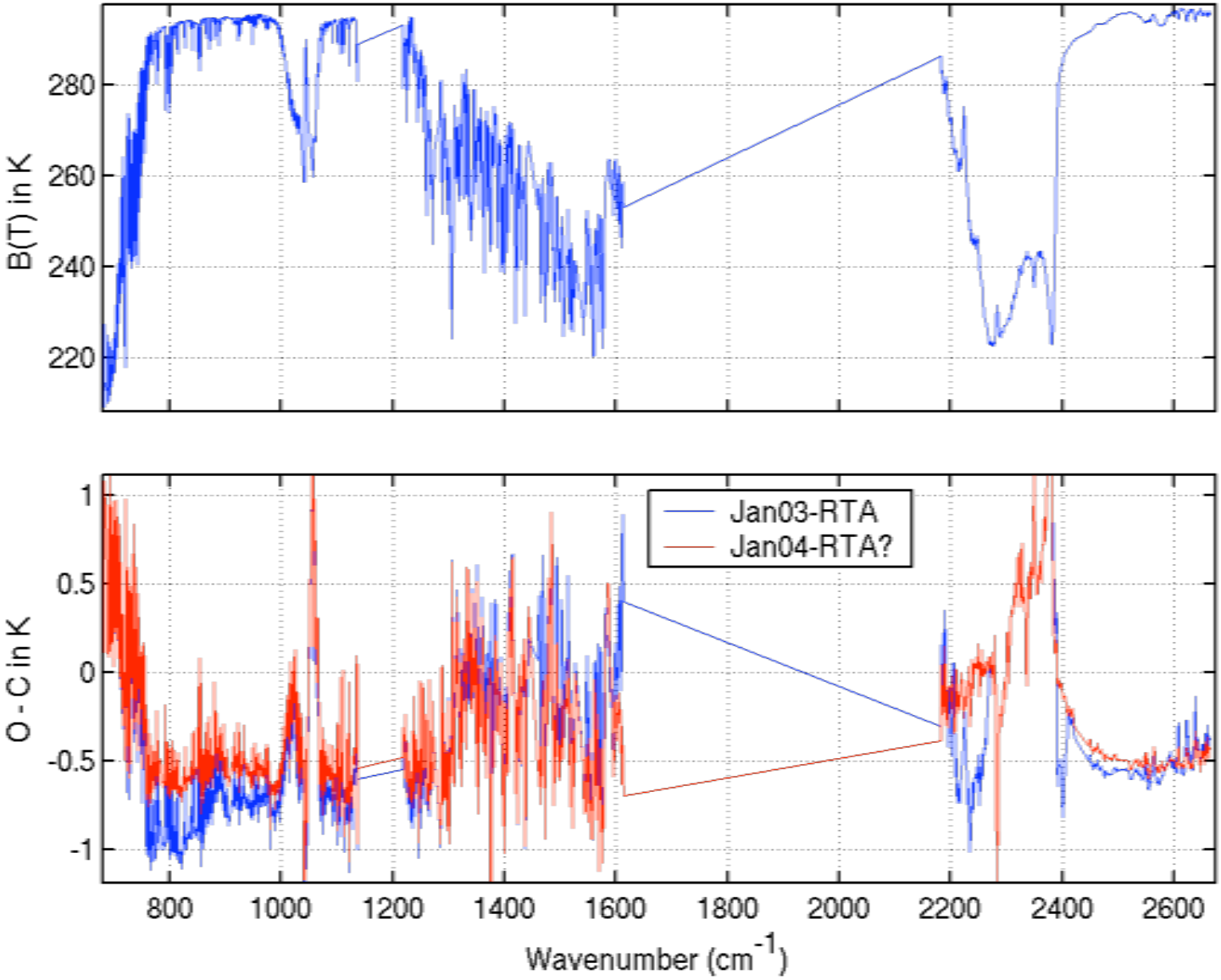
L. Strow, S. Hannon, S. De-Souza Machado, H. Motteler

- Concentrate first on the water vapor continuum
  - Fix the lower altitude channels first, then work our way up in the atmosphere
- What is the truth?
- Procedures to validate, improve the water continuum
- Error analysis, including ECMWF fields
- Fixed gas/CO_2 tuning, preliminary results
  - Again, truth is the problem, especially in the upper atmosphere
- Future work

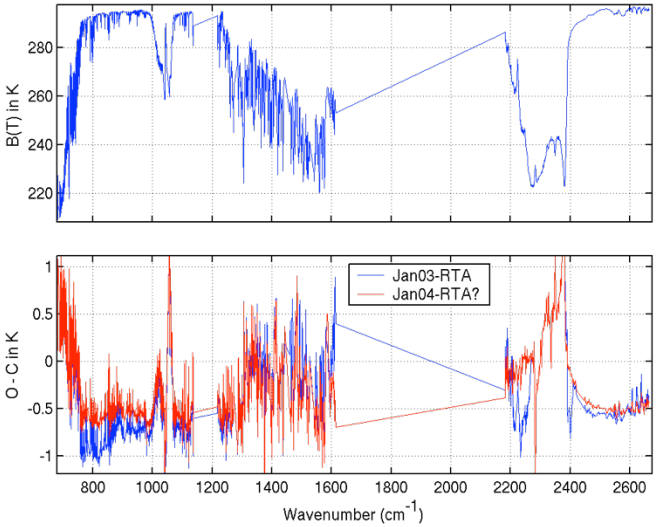
Starting Point – H_2O Continuum

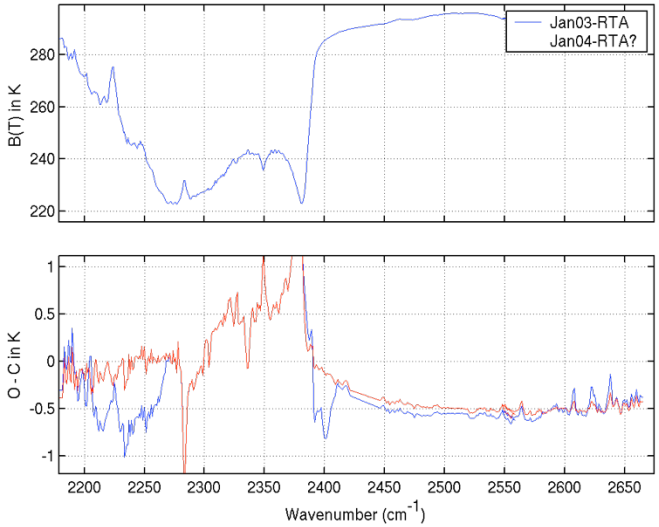
- January 2003 RTA quickly modified from theory based on ~1 month of validation data from Fall 2002.
- Main modifications at that time were to the water vapor continuum, primarily based on ECMWF model fields.
- Basis of changes: minimize the dependence of the bias on total column water;
  - Suggested large changes in shortwave continuum, which were implemented beyond 2400 cm^{-1}.
  - Longwave continuum was also increased for the same reason.
- Used MT_CKD(V1) as the starting point for validation, released Spring 2003, changes based on DOE-ARM Aeri work by U.Wisc.
- ARM-TWP has lots of water (~40 mm), and a reasonable number of "clear" overpasses.
- Goal: Agreement between AERI, AIRS-TWP, AIRS-ECMWF

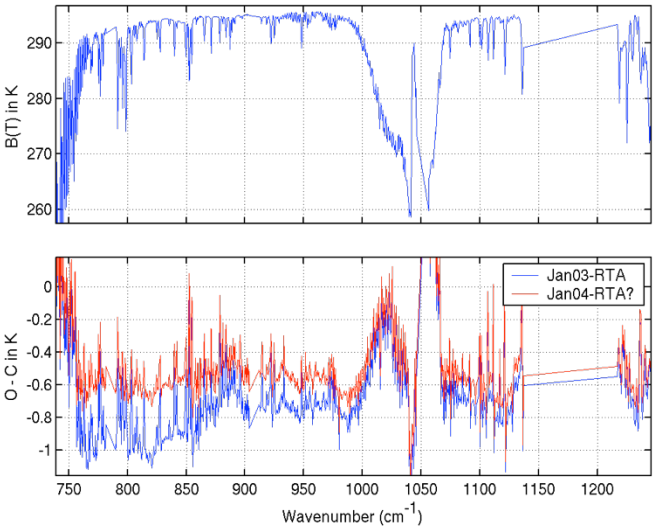
Jan03-RTA vs Jan04-RTA??

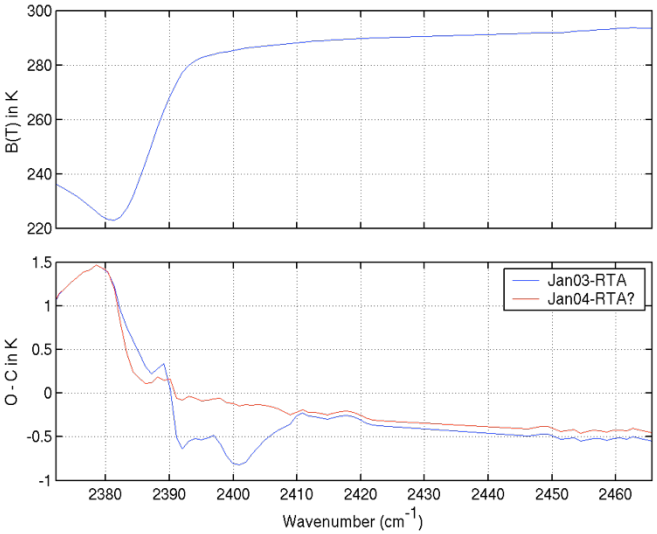


Jan03-RTA vs Jan04-RTA??





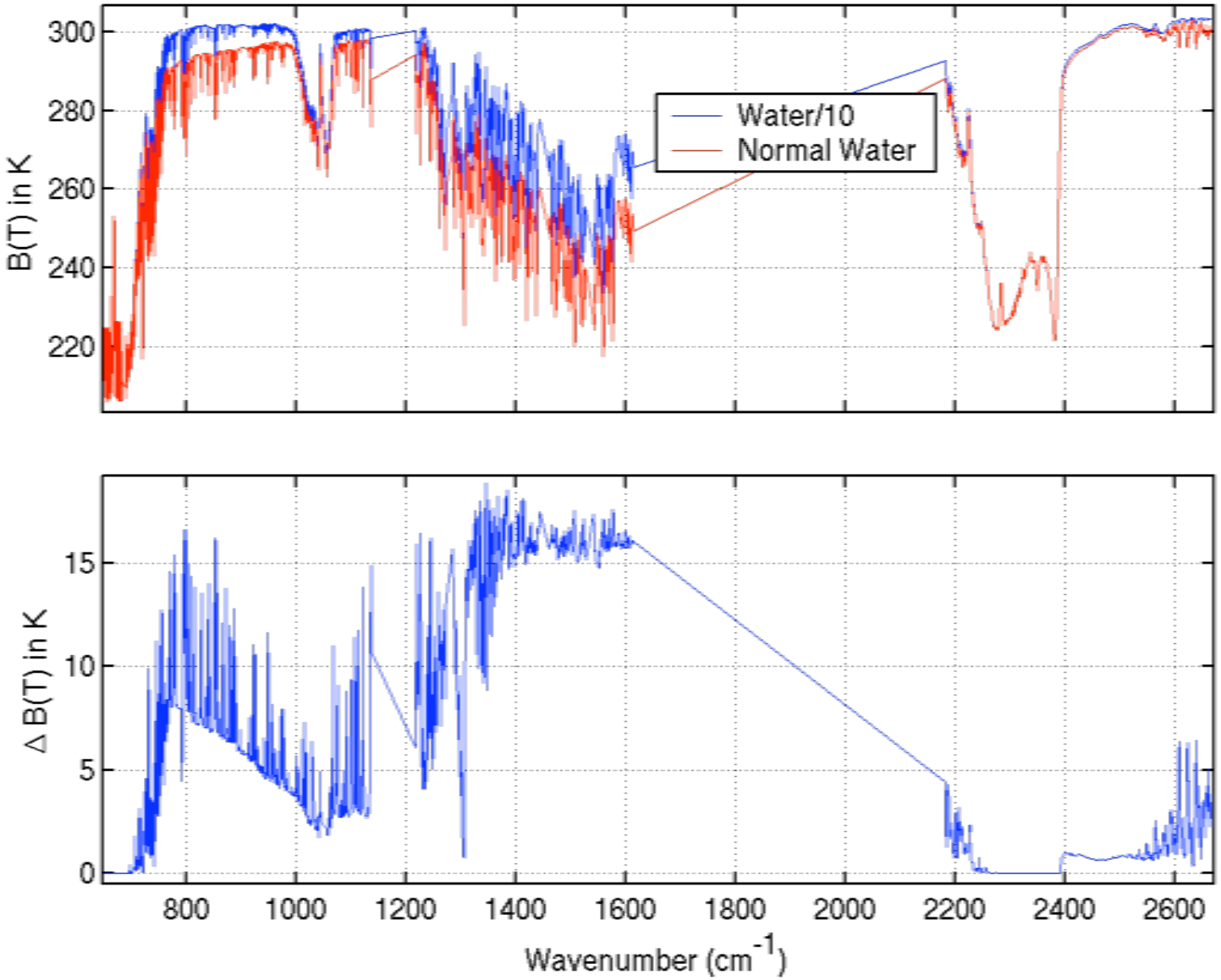




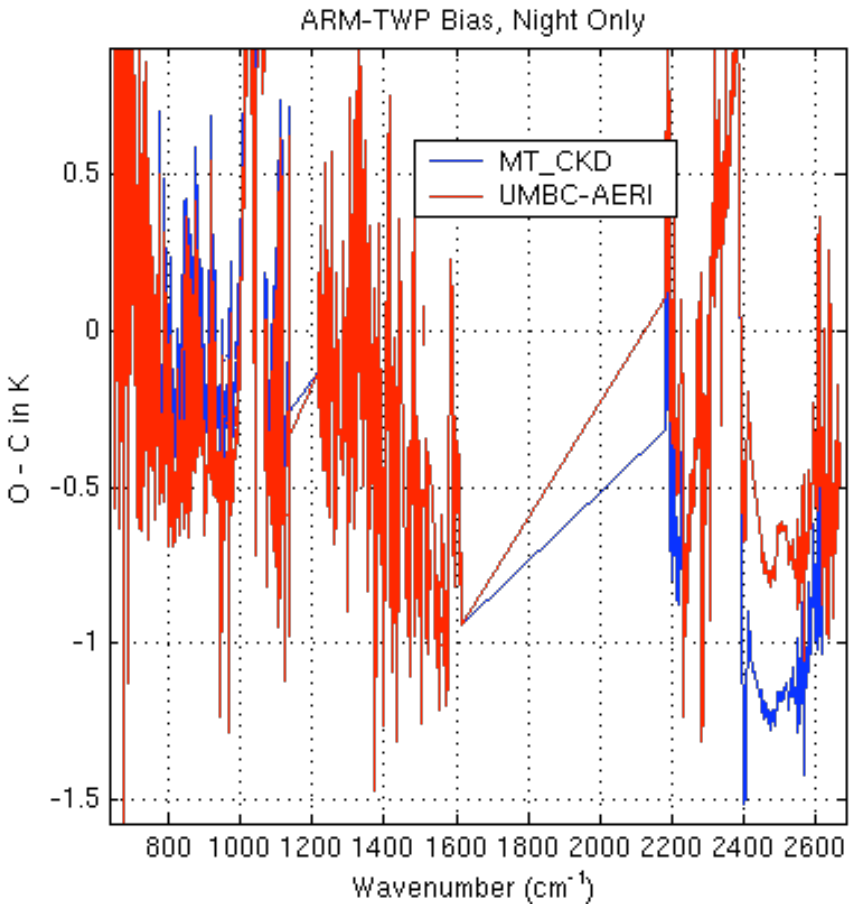
Approach to Water Continuum

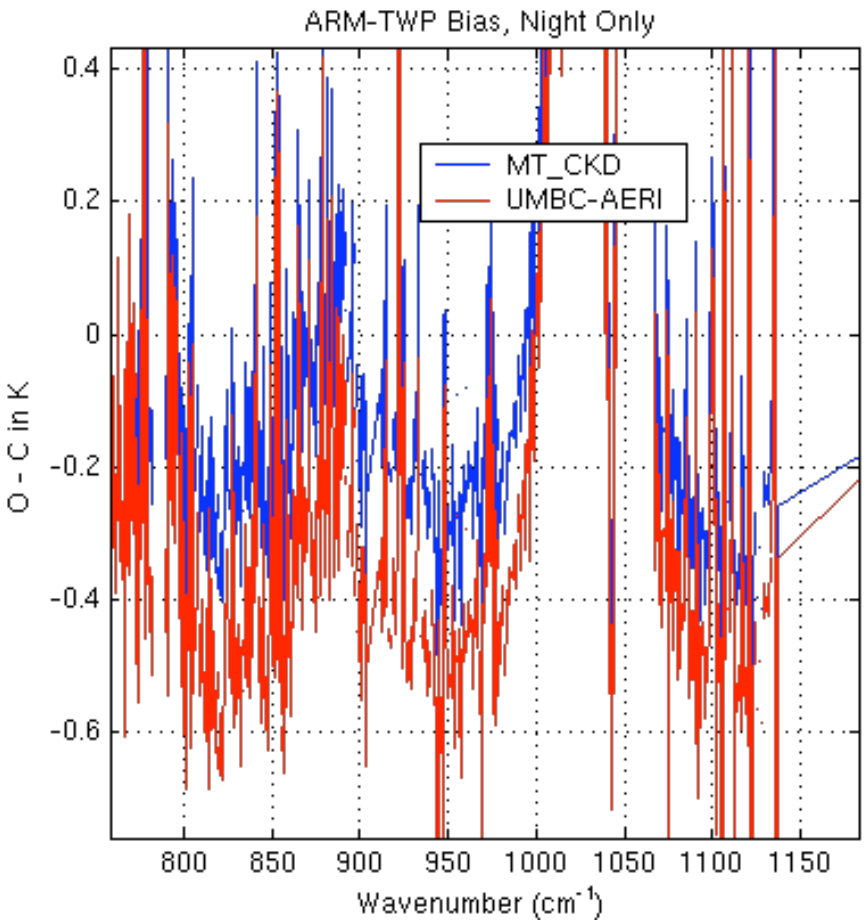
- Starting Point: MT_CKD continuum released Spring 2003
- Use AIRS-TWP observations as basis for validation of RTA
  - Over ocean, good emissivity
  - Lot's of water
  - Reasonable number of "clear" observations
  - RS-90 sondes with microwave scaling for total column water
  - Determine SST with "2616 cm-1" channel, **but** MT_CKD gave large biases there even though the continuum is small in this region
  - (1) Bootstrap with ECMWF-derived "2616 cm-1" bias, and/or (2) Analyze AERI shortwave data for continuum (Thanks to D. Turner and D. Tobin for the data!)
  - Once get SST, derive continuum using AIRS-TWP data
- Apply AERI, TWP continua to ECMWF, "calibrate" ECMWF statistical global column water
- Re-analyze AERI raw data using variation in radiance with total column water – MT_CKD only used AERI data at ~40 mm total column water
- Choose "best" continuum

Strength of Water Continuum, ARM-TWP



ARM-TWP Biases using Continuua from 2 Analyses of AERI Data



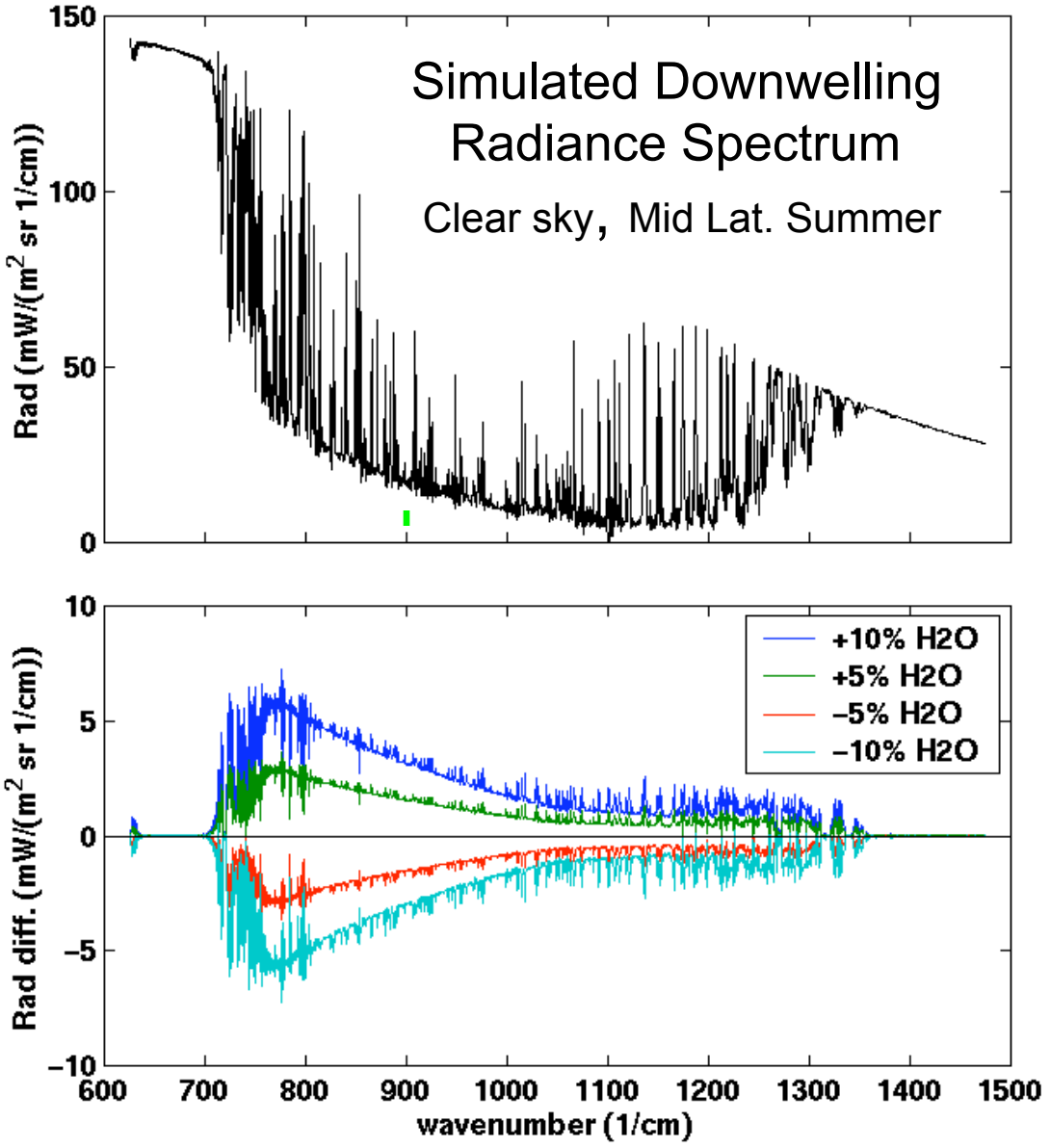


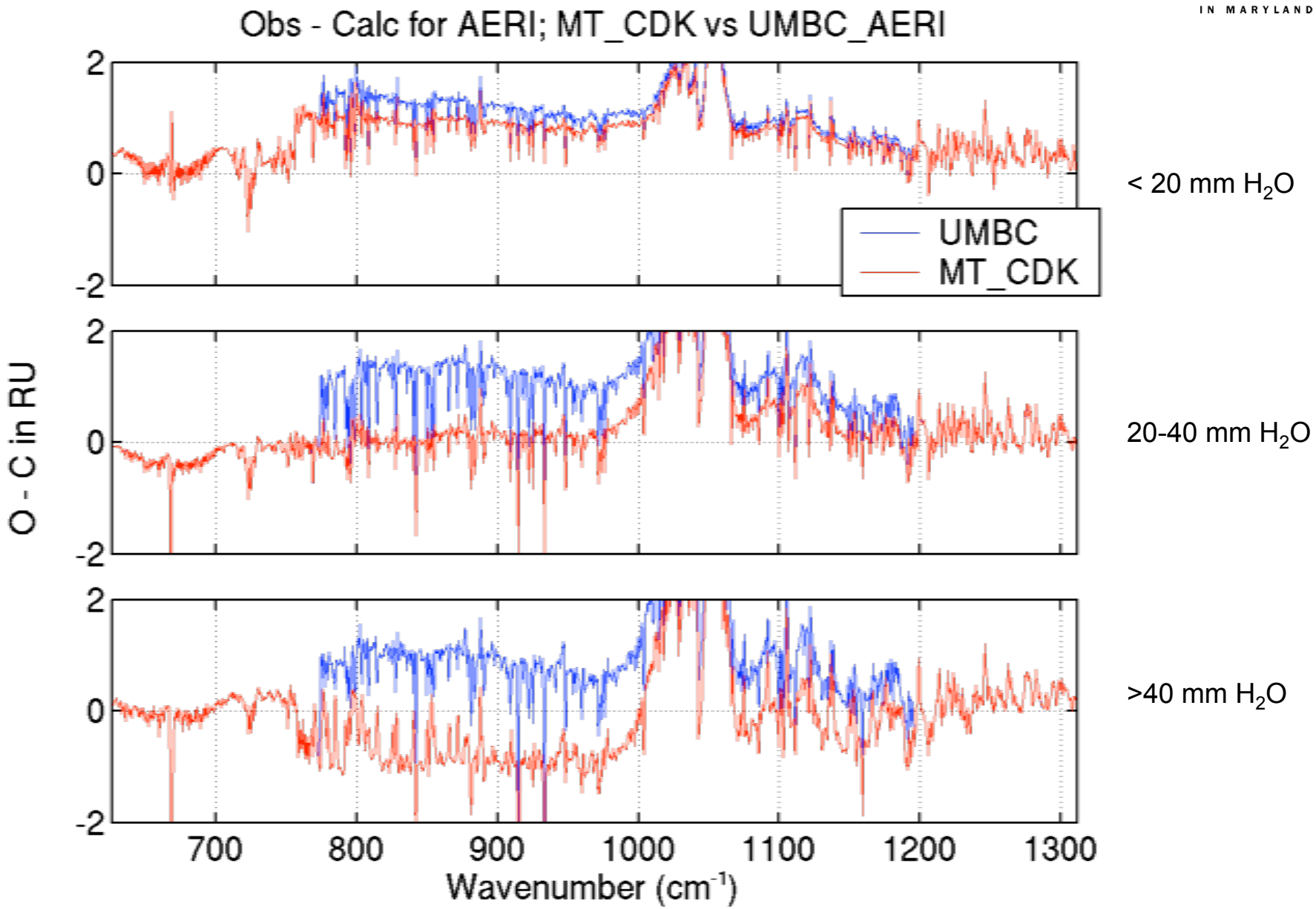
Lower Troposphere Water Vapor Measurement Goal: <2% in precipitable water vapor

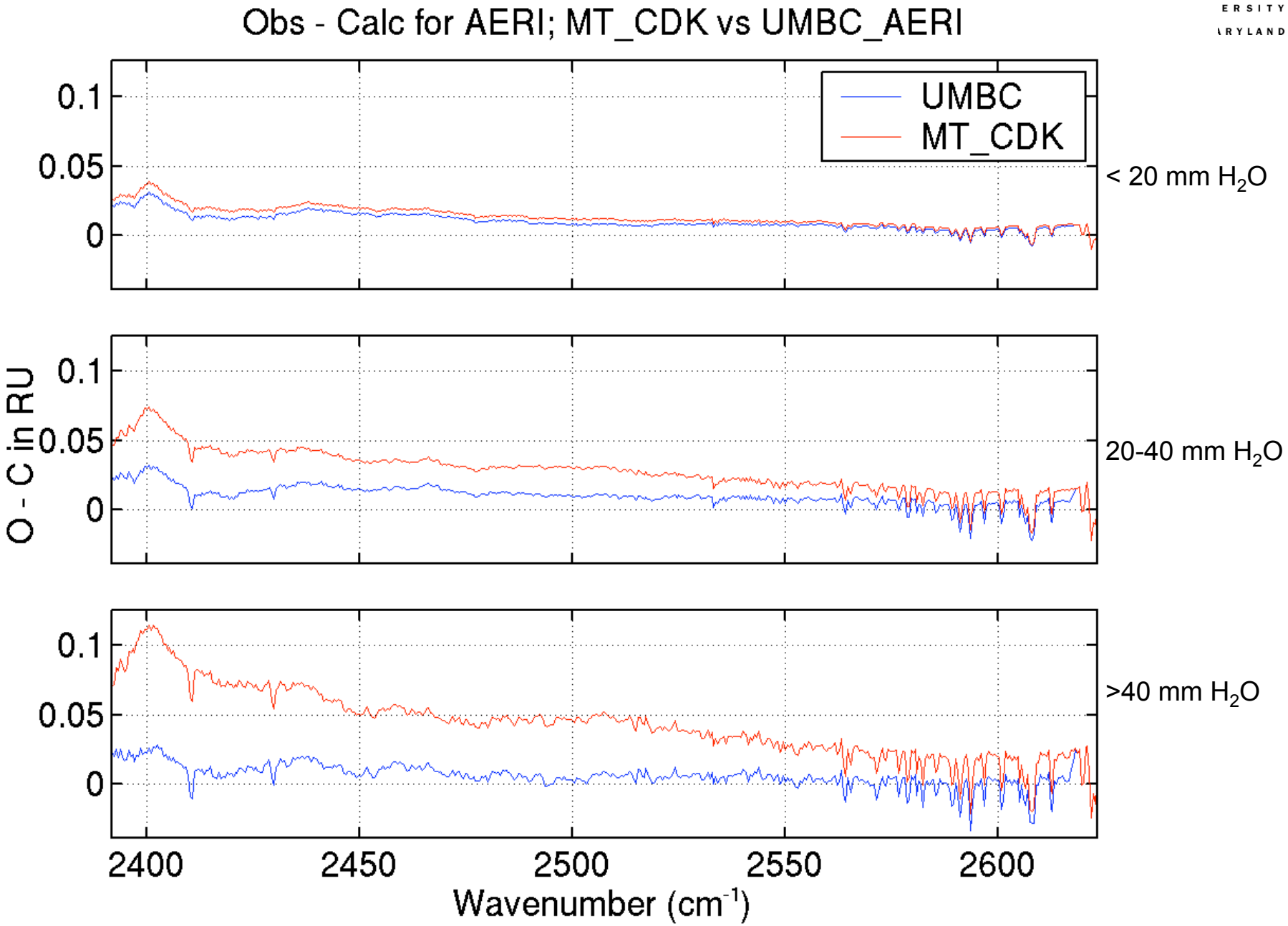
Based on desire to improve clear sky absorption models and to resolve significant climate changes, such as the effect of CO_2 doubling on surface radiation budget.

For midlatitude conditions, a 10% H_2O perturbation results in a ~7 W/m^2 change in downwelling Flux at the surface.

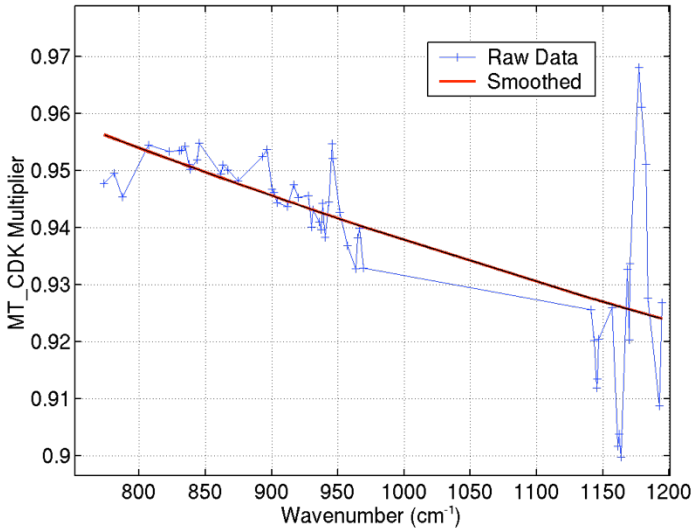
2% is order (1 W/m^2)

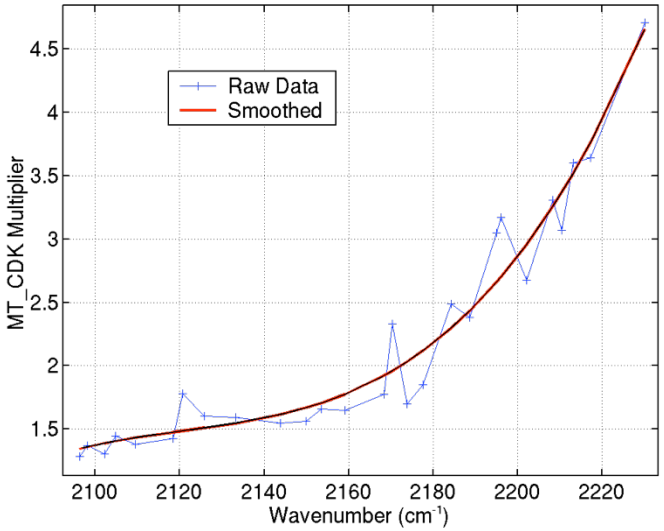


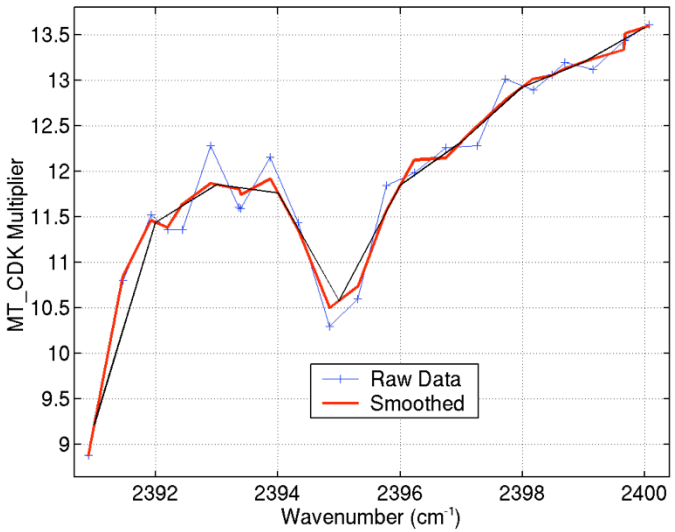

Obs - Calc for AERI; MT_CDK vs UMBC_AERI
O - C in RU
2
0
-2
UMBC
MT_CDK
< 20 mm H2O
20-40 mm H2O
>40 mm H2O
700
800
900
1000
1100
1200
1300
Wavenumber (cm-1)

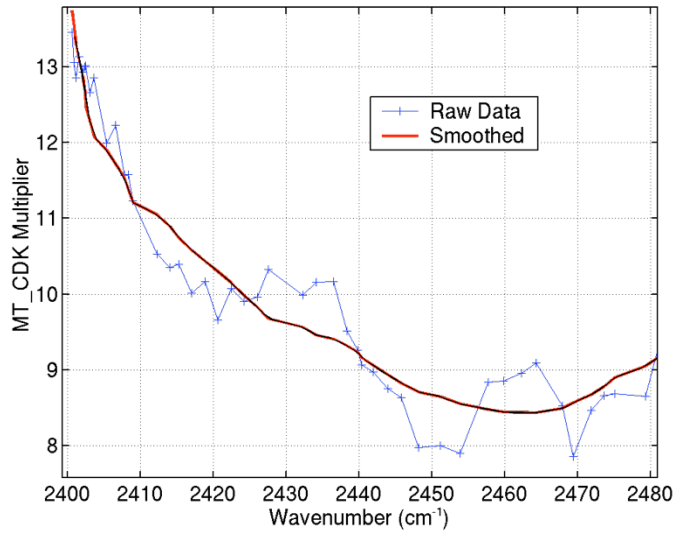

Obs - Calc for AERI; MT_CDK vs UMBC_AERI
UMBC
MT_CDK
< 20 mm H2O
20-40 mm H2O
>40 mm H2O
O - C in RU
0.1
0.05
0
2400
2450
2500
2550
2600
Wavenumber (cm-1)

AERI-derived Changes to MT_CKD

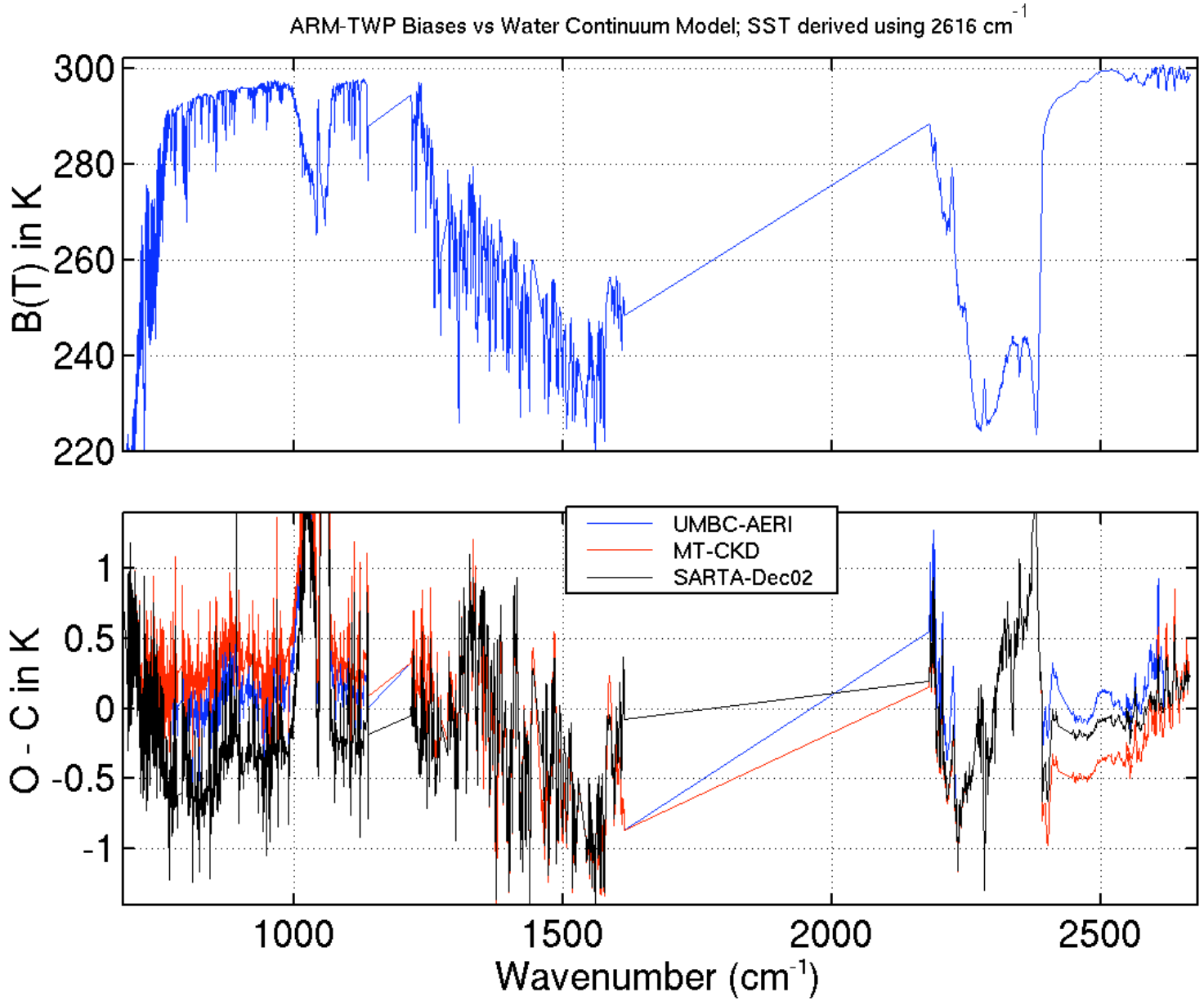




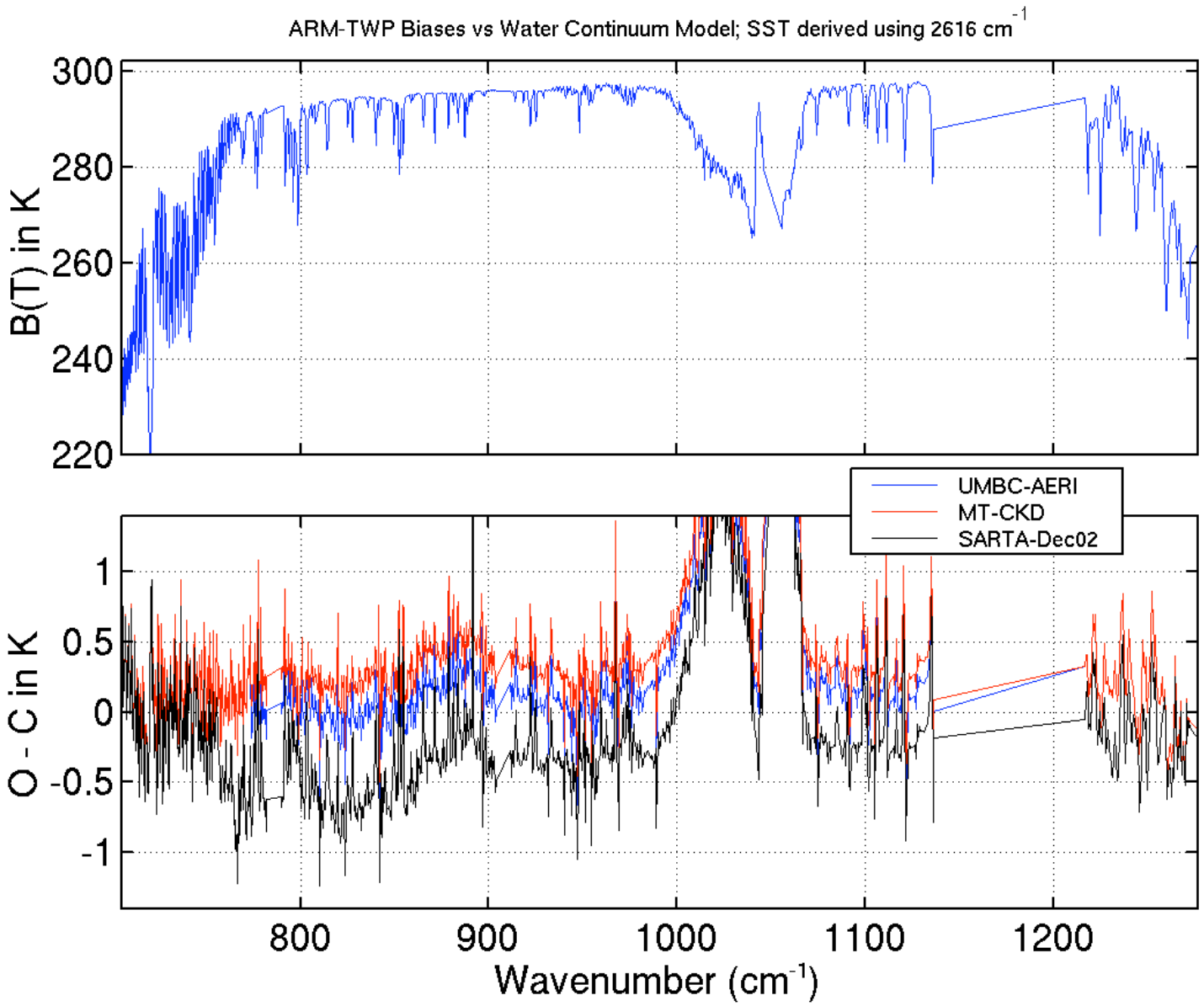




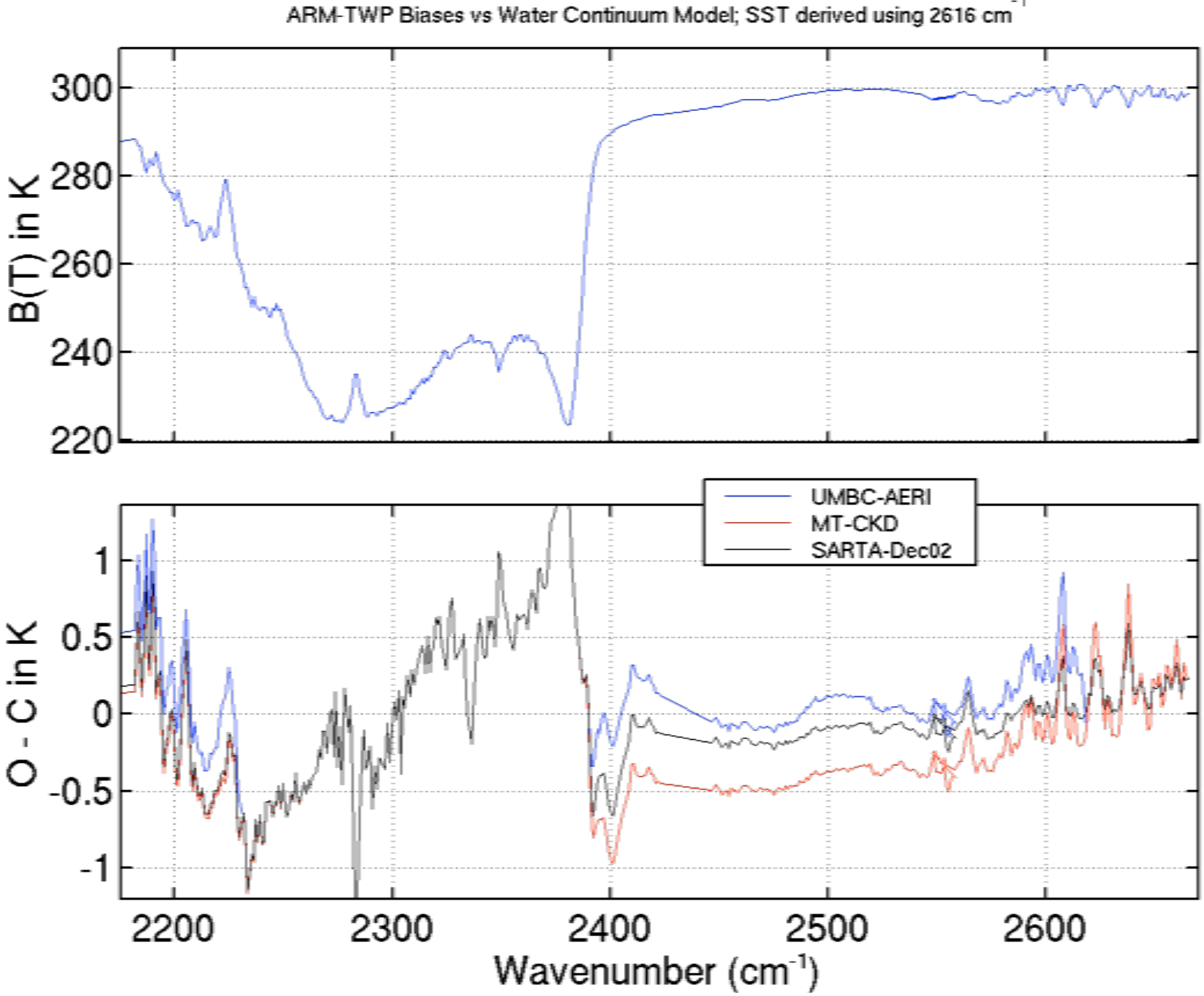
ARM-TWP Biases for 3 Continuum Models



ARM-TWP for 3 Continuum Models

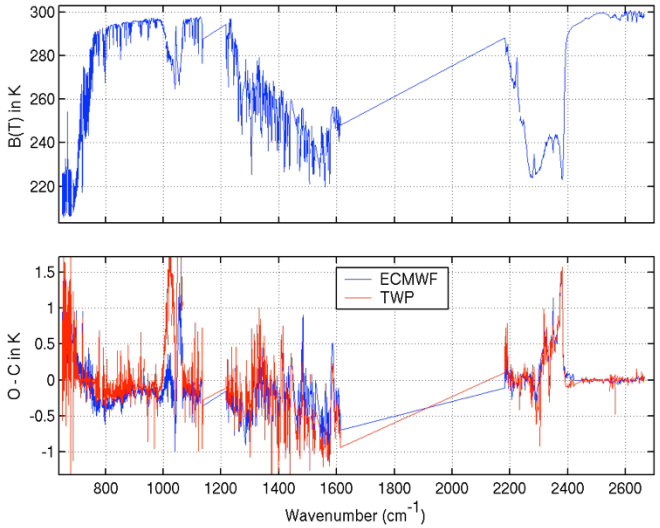


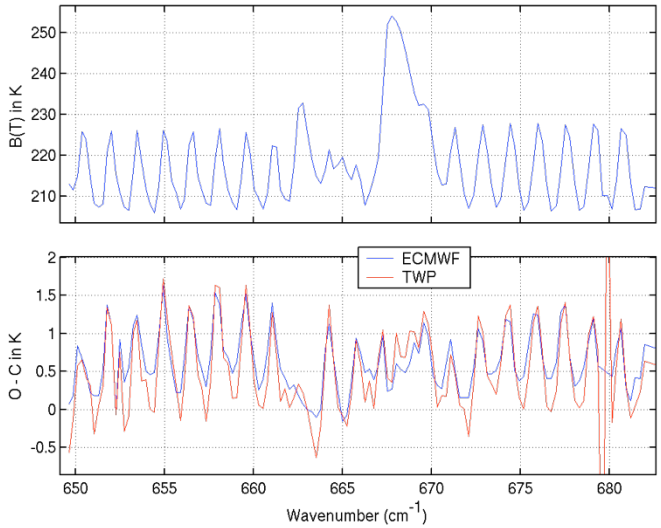
ARM-TWP Biases for 3 Continuum Models

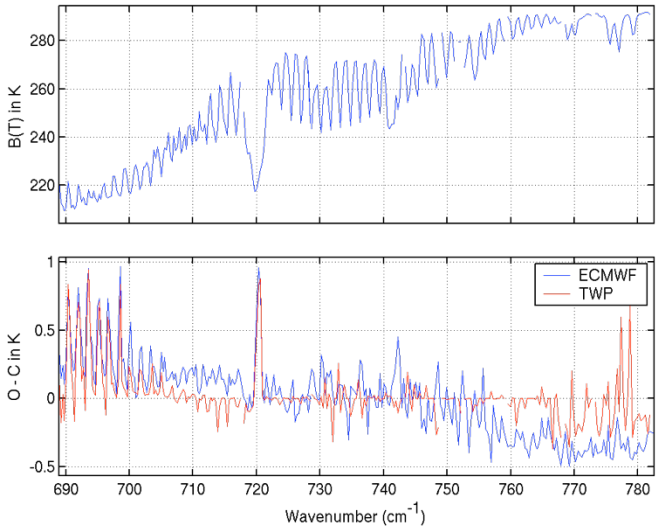


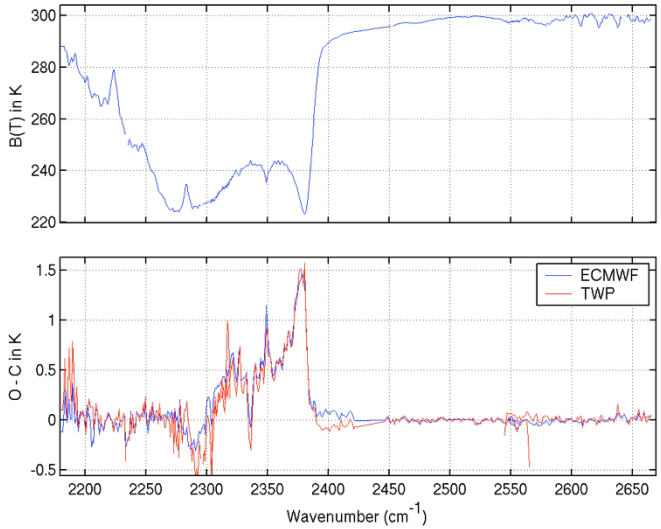
ECMWF vs TWP Biases

(using continuum derived from TWP)

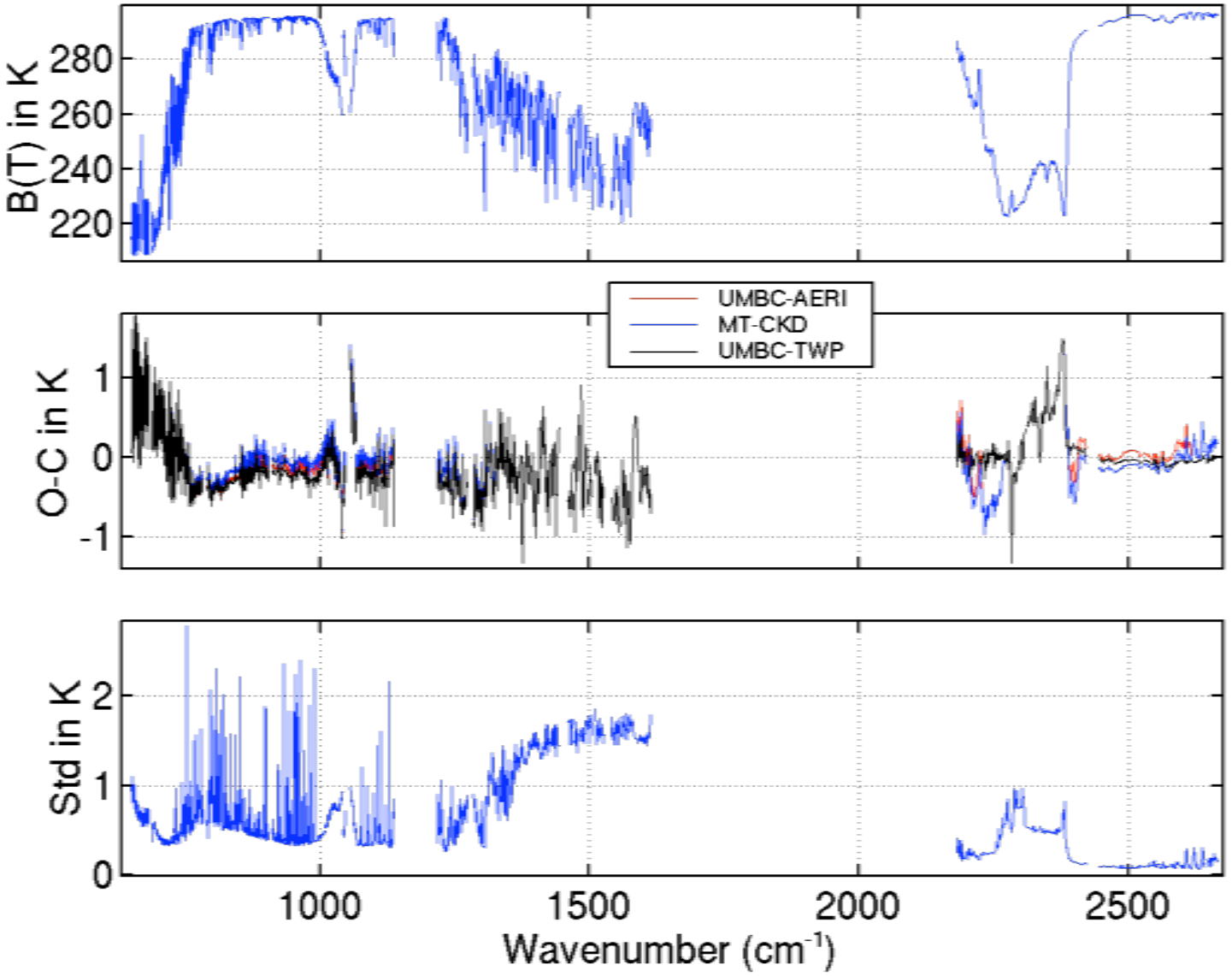




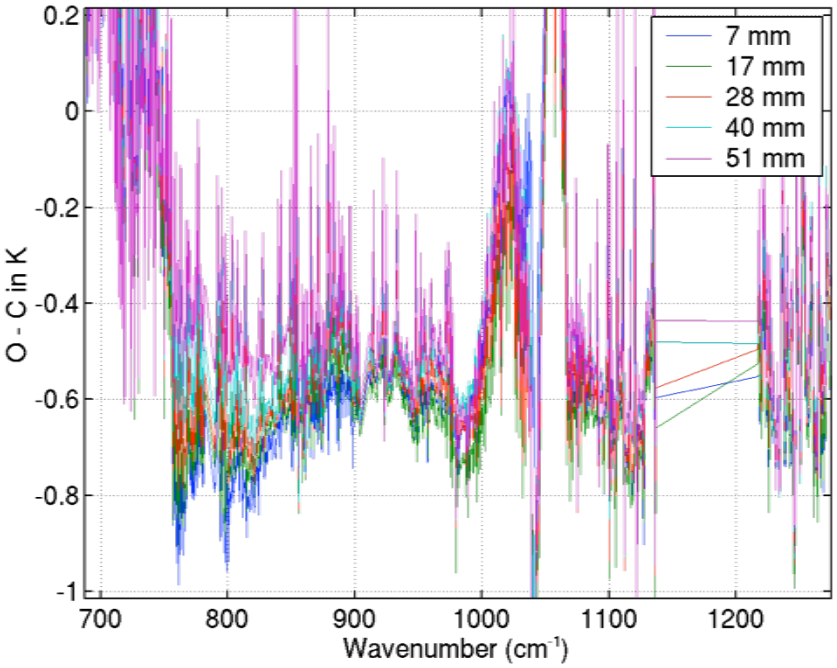


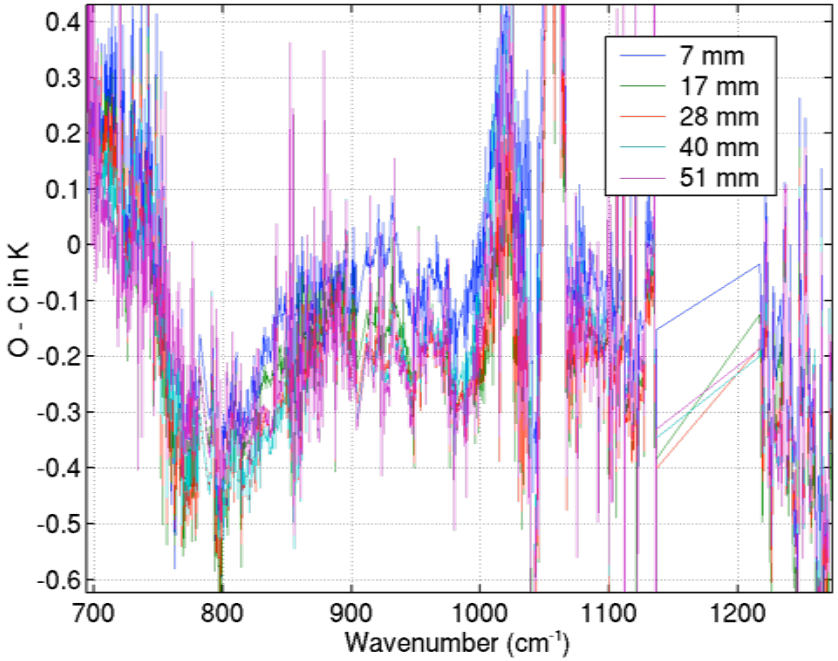


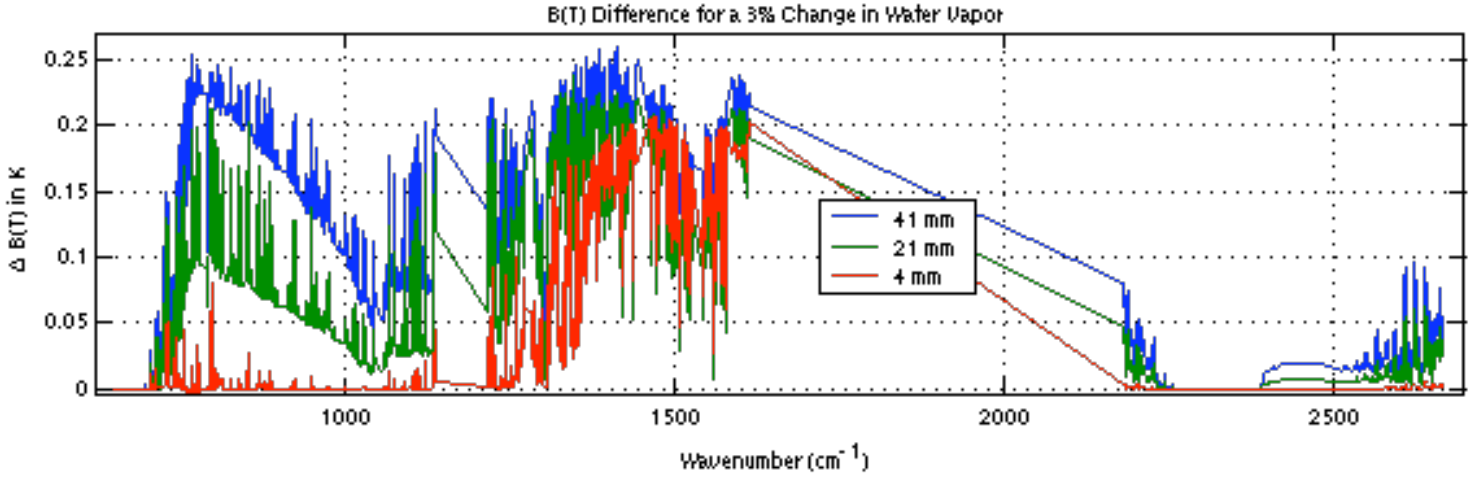
ECMWF Biases for 3 Continuum Models



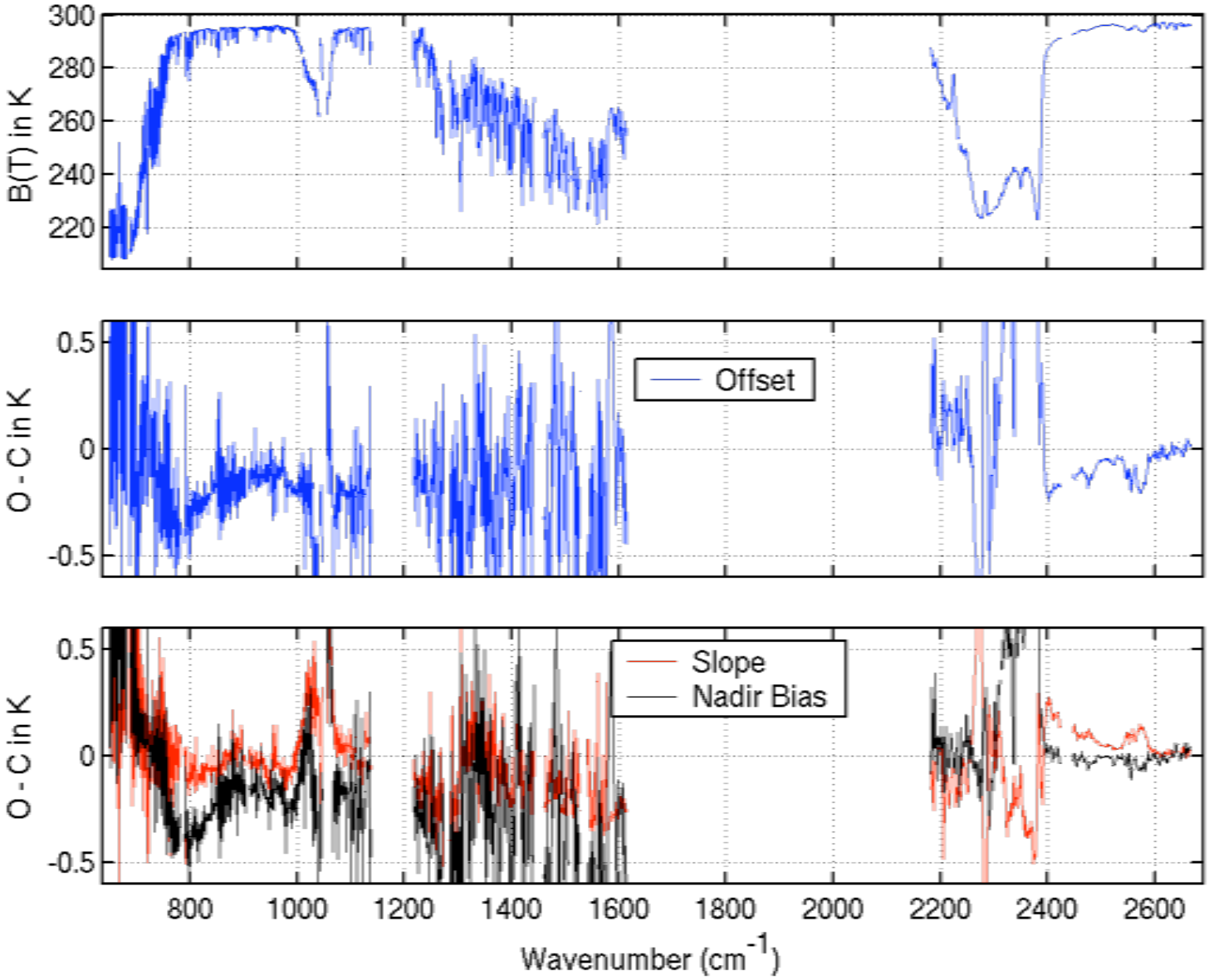
ECMWF Bias in Longwave - ~2% Accuracy in Total column Water?



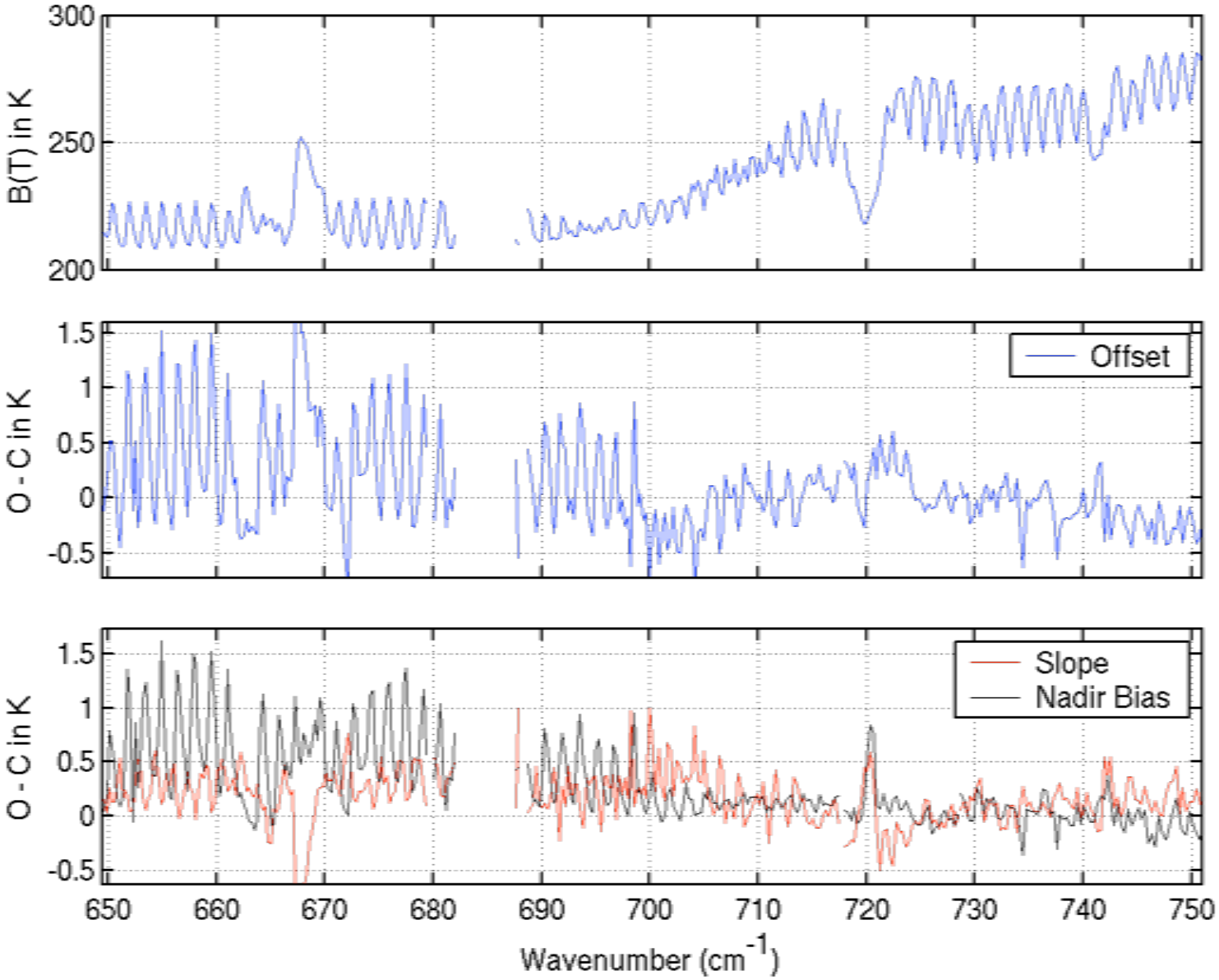




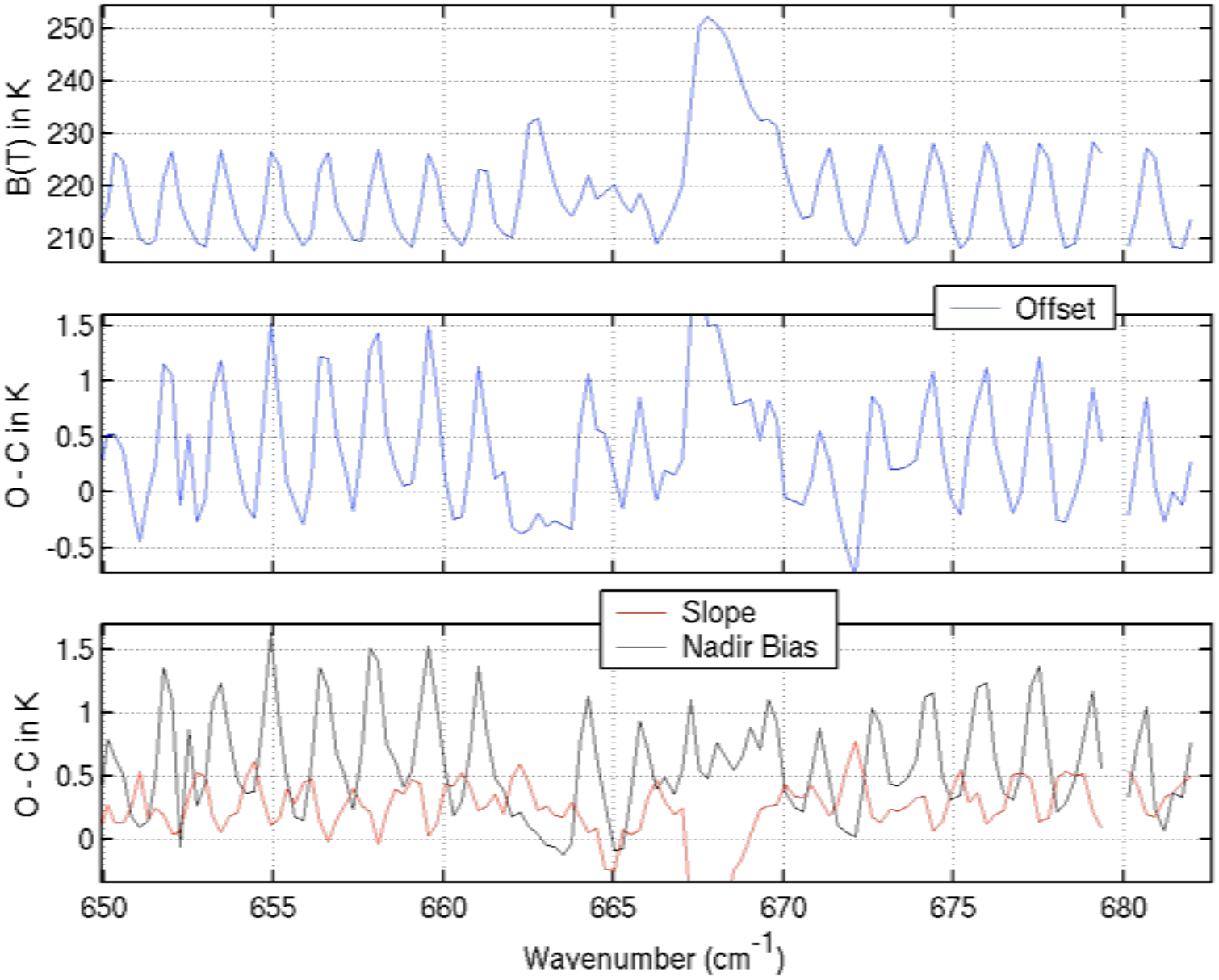
ECMWF Bias vs Secant(θ)



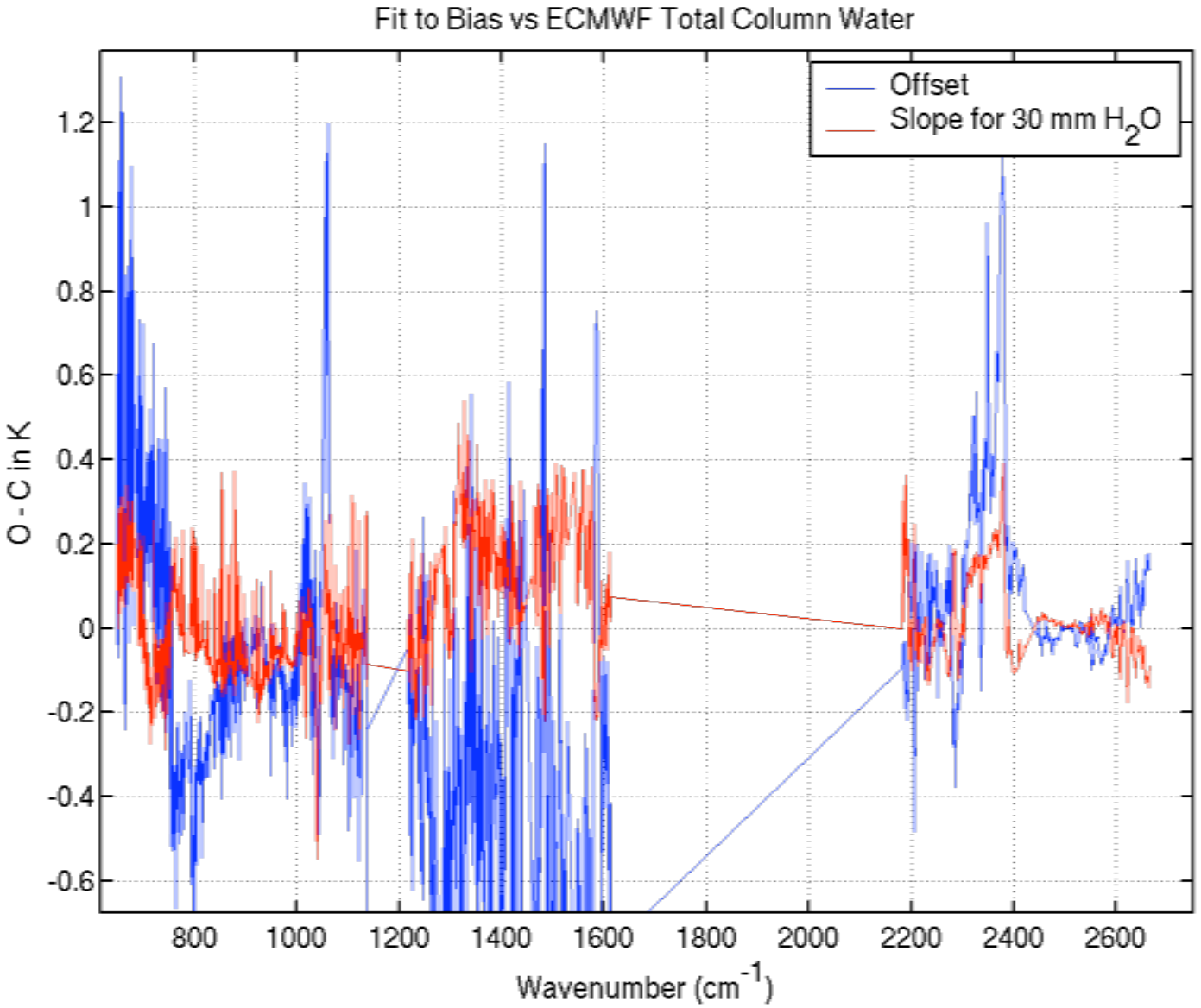
ECMWF Bias vs Secant(θ)



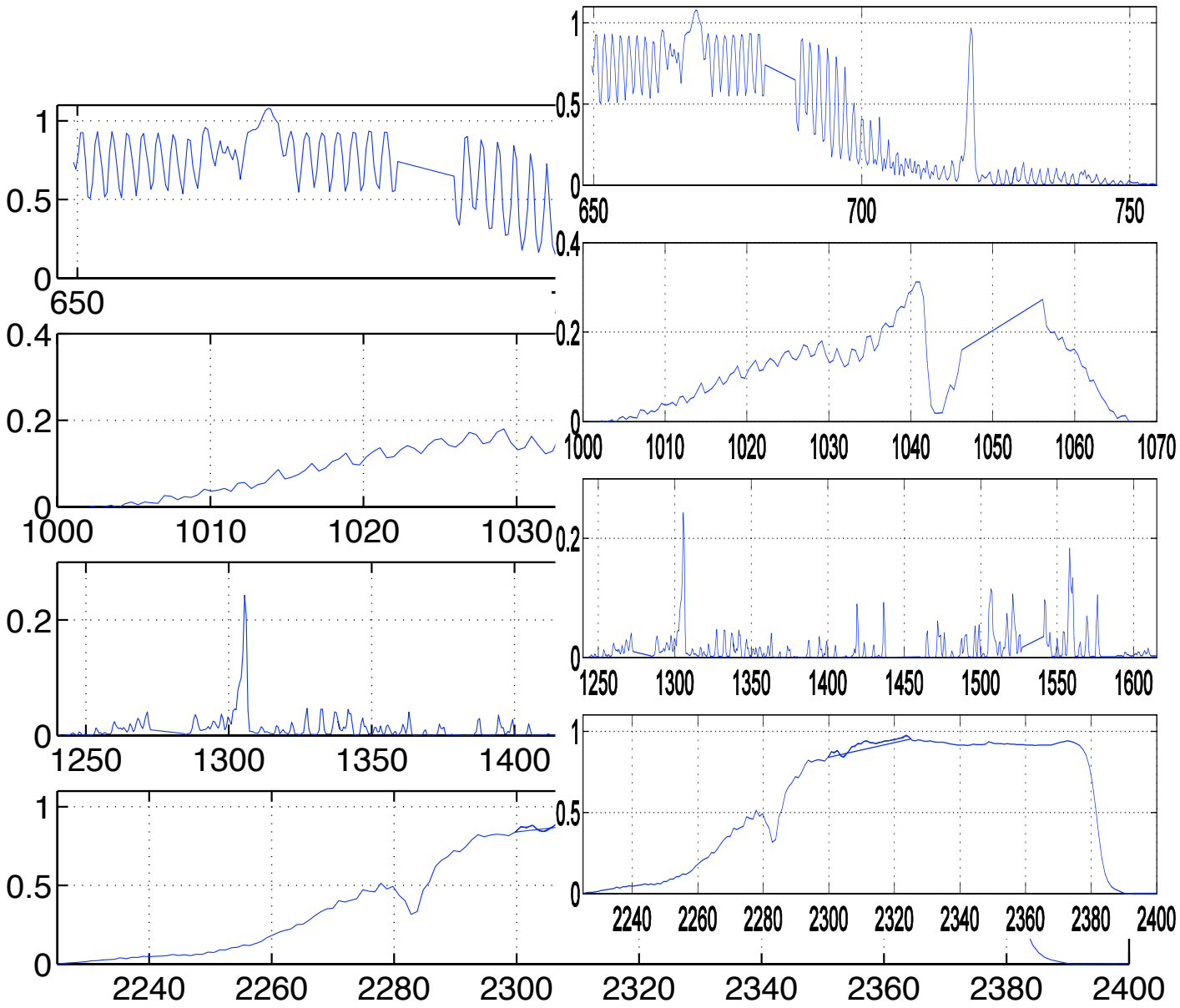
ECMWF Bias vs Secant(θ)



ECMWF Bias vs Total Column Water

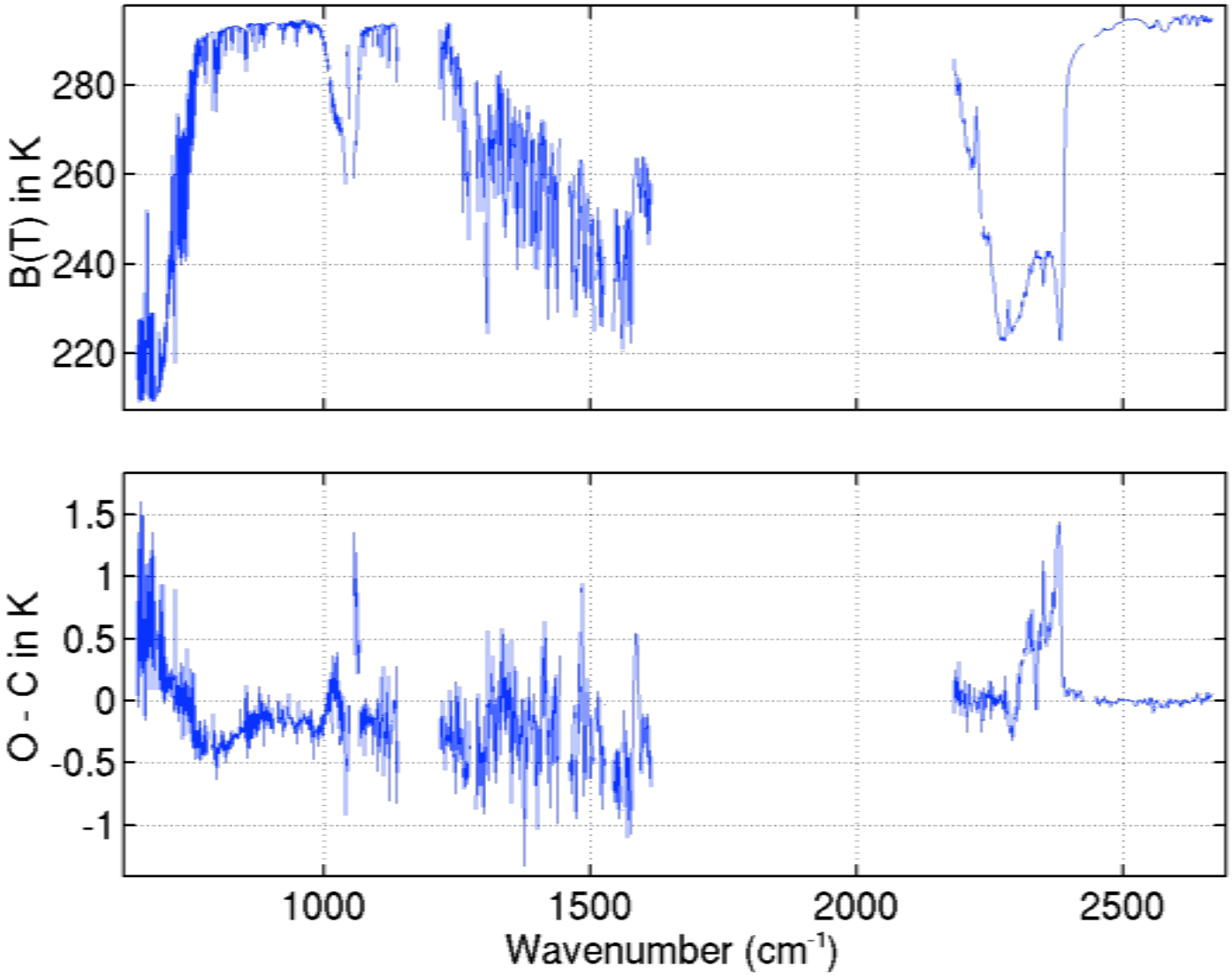


Bias for 1K ECMWF Offset above 60 mbar

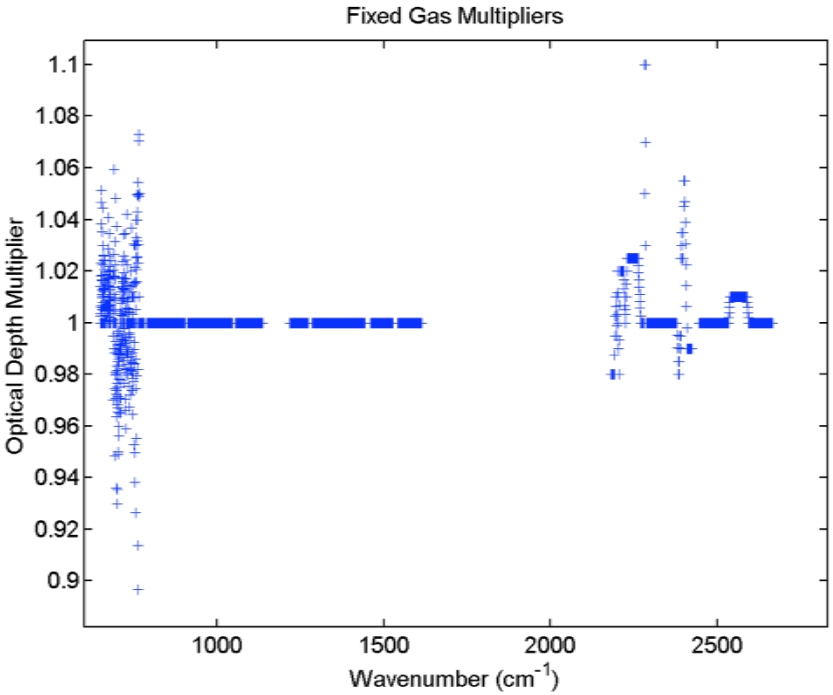


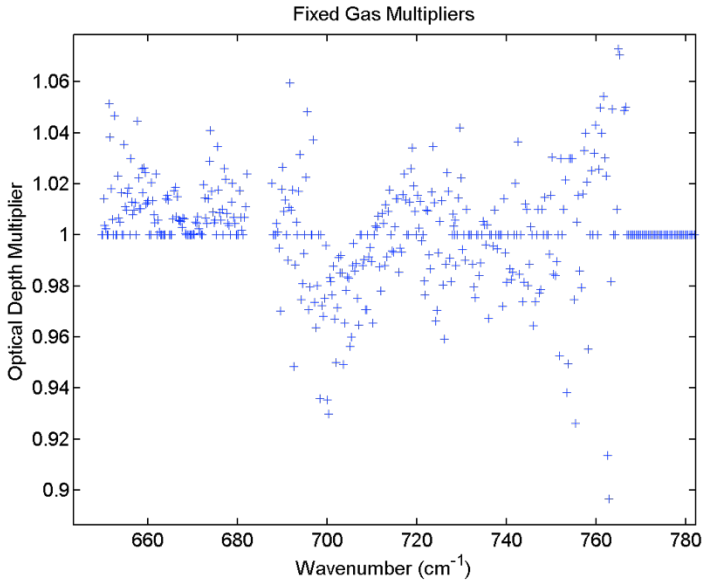
Fixed Gas Tuning

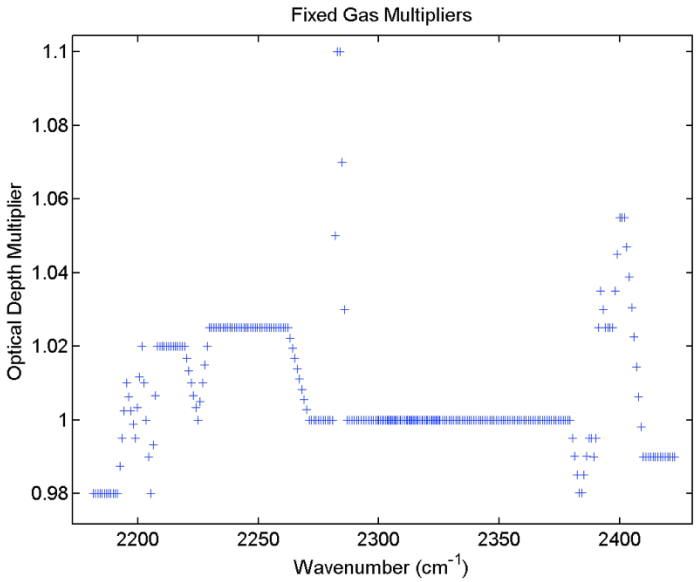
- Set SST in shortwave
- Modified fixed-gas optical depth with ARM-TWP
- Strong water channels not touched
- No fixed-gas tuning above 60 mbar



Fixed Gas Multipliers from TWP

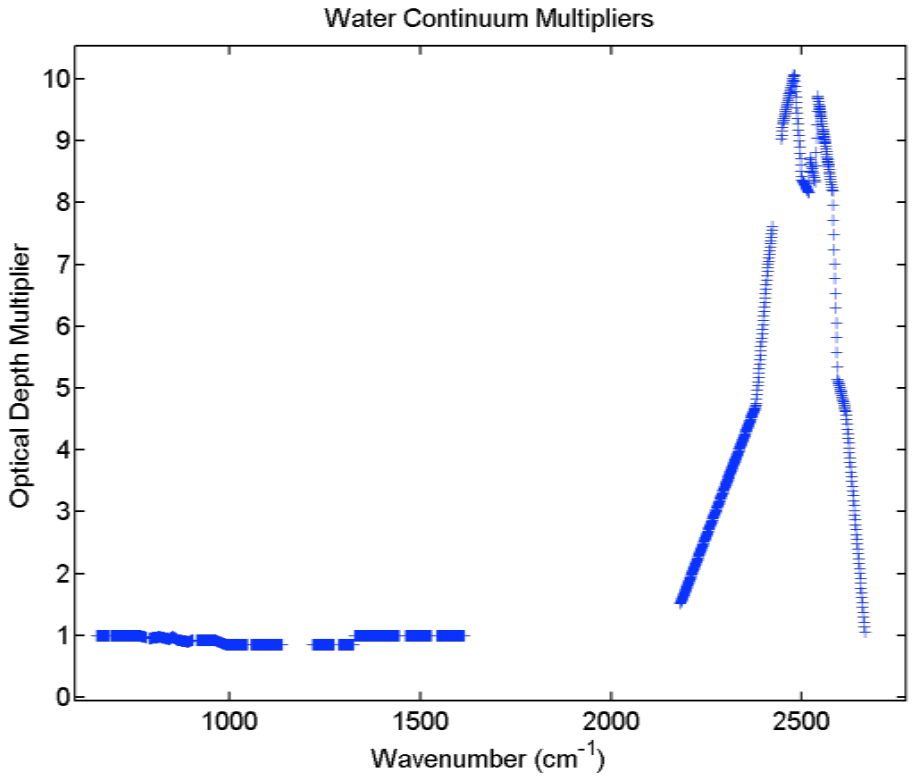


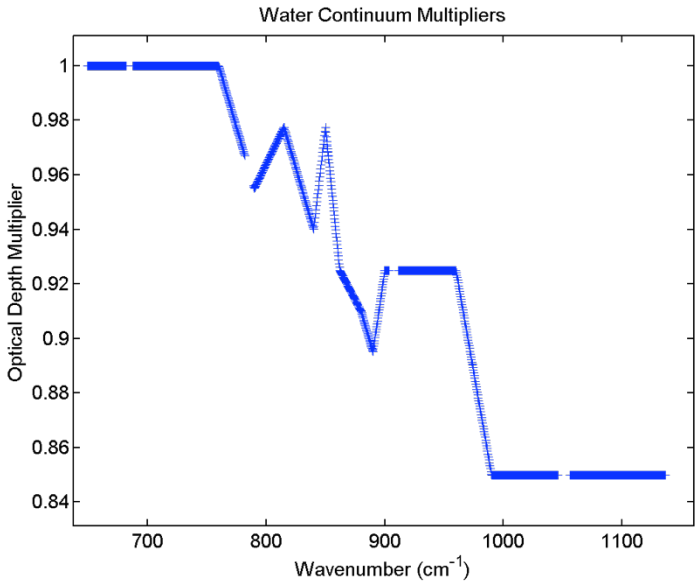


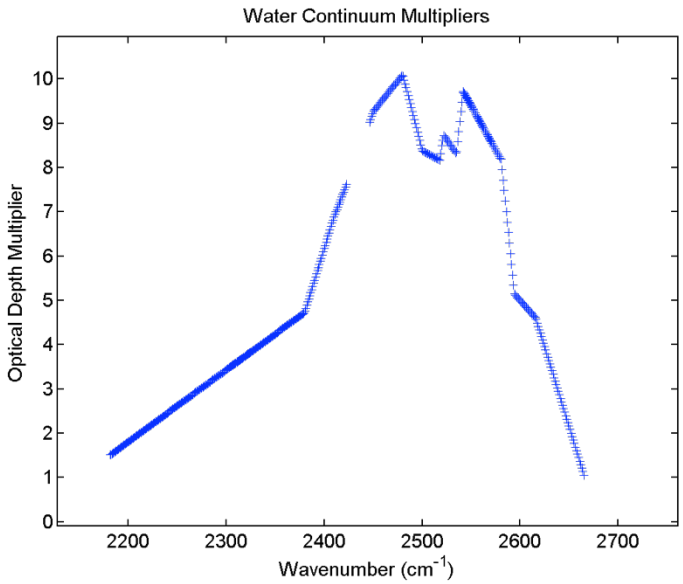


- Trial fixed gas optical depth multipliers were generated using the ARM-TWP AIRS validation data.
- Longwave multipliers are reasonable
- 2400 cm^{-1} multipliers seem a little large

MT_CKD Continuum Multipliers

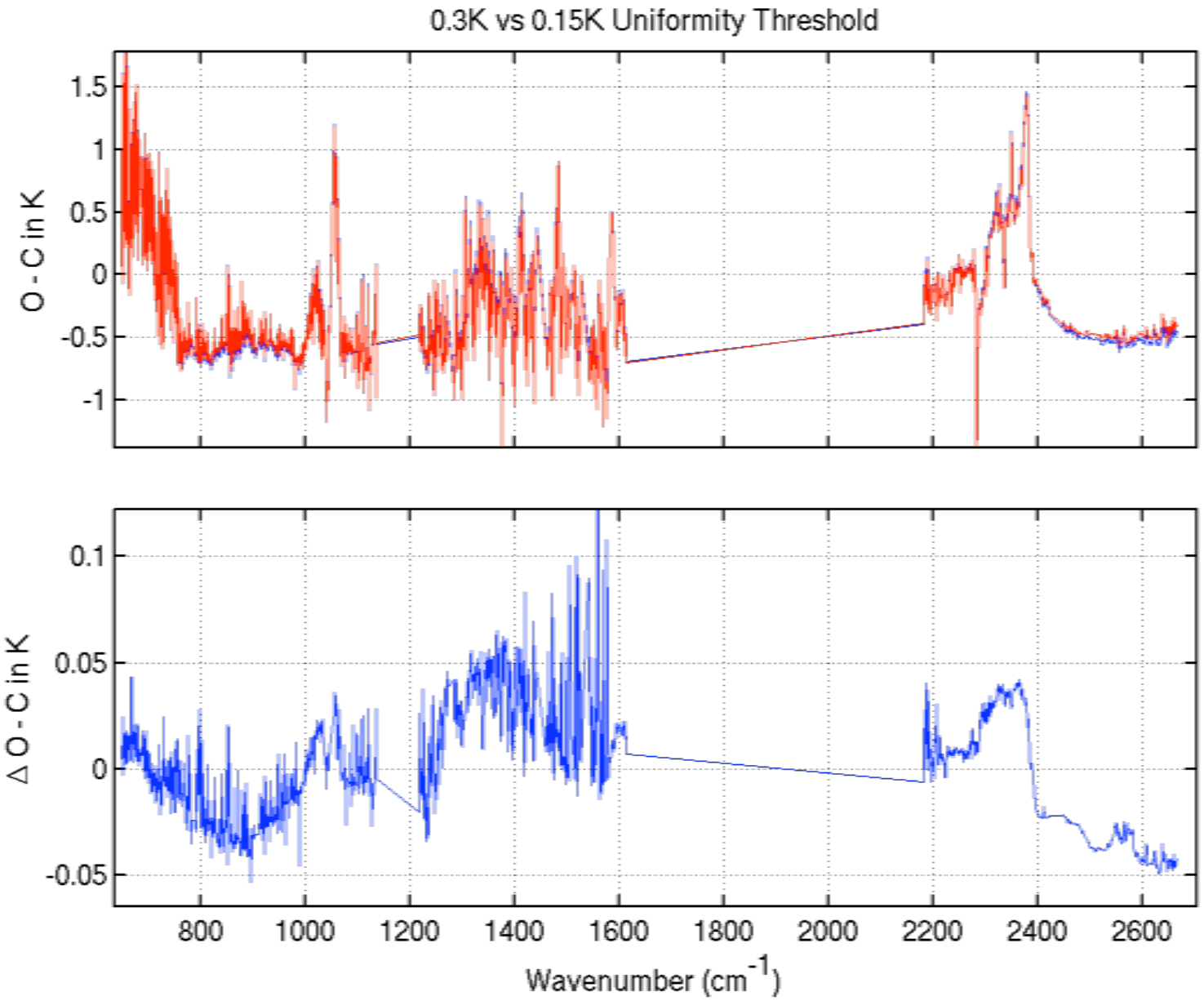




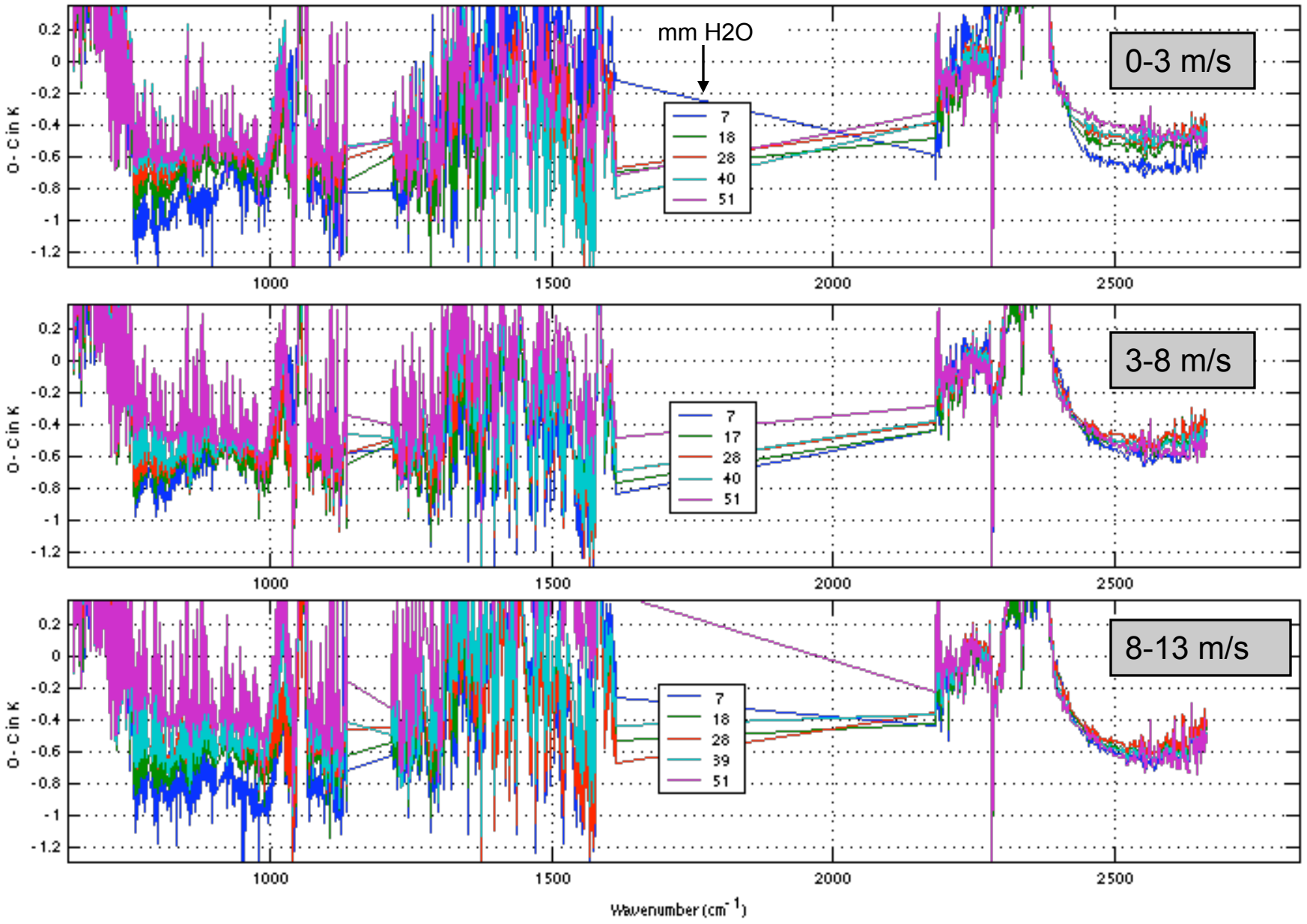


- These results based on AIRS-TWP validation data in longwave, TWP and ECMWF shortwave
- Longwave multipliers agree with UMBC-AERI results below 1000 cm^{-1}
- Still working to merge TWP and AERI in 2400 cm^{-1} region, we are close. Linear vs quadratic?

Sensitivity of Bias to Uniform Threshold

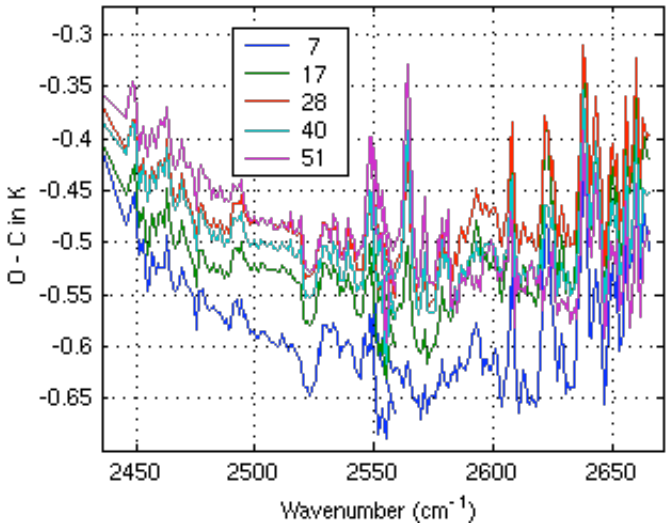


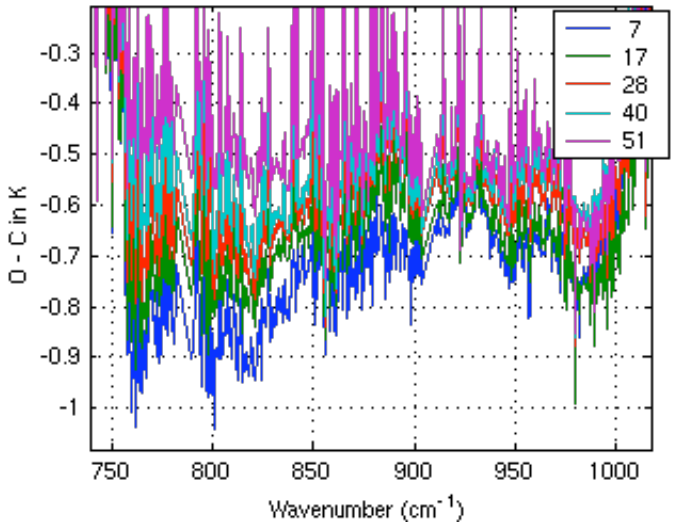
Bias vs Wind Speed and Total Column Water



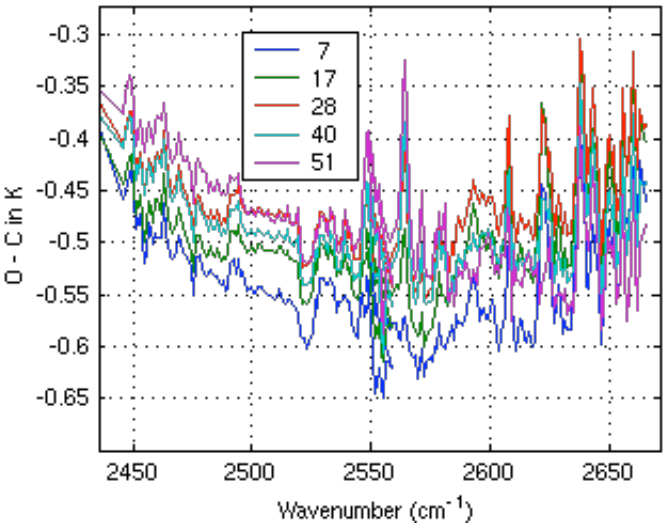
ECMWF Wind Speed in Masuda ε

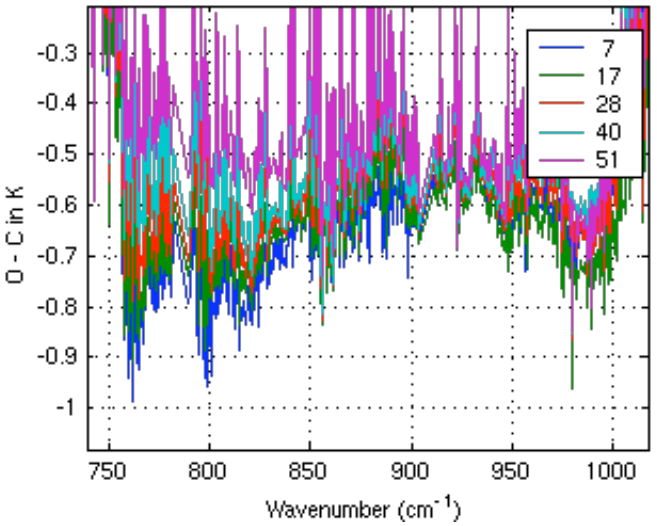
Masuda wpeed = 0





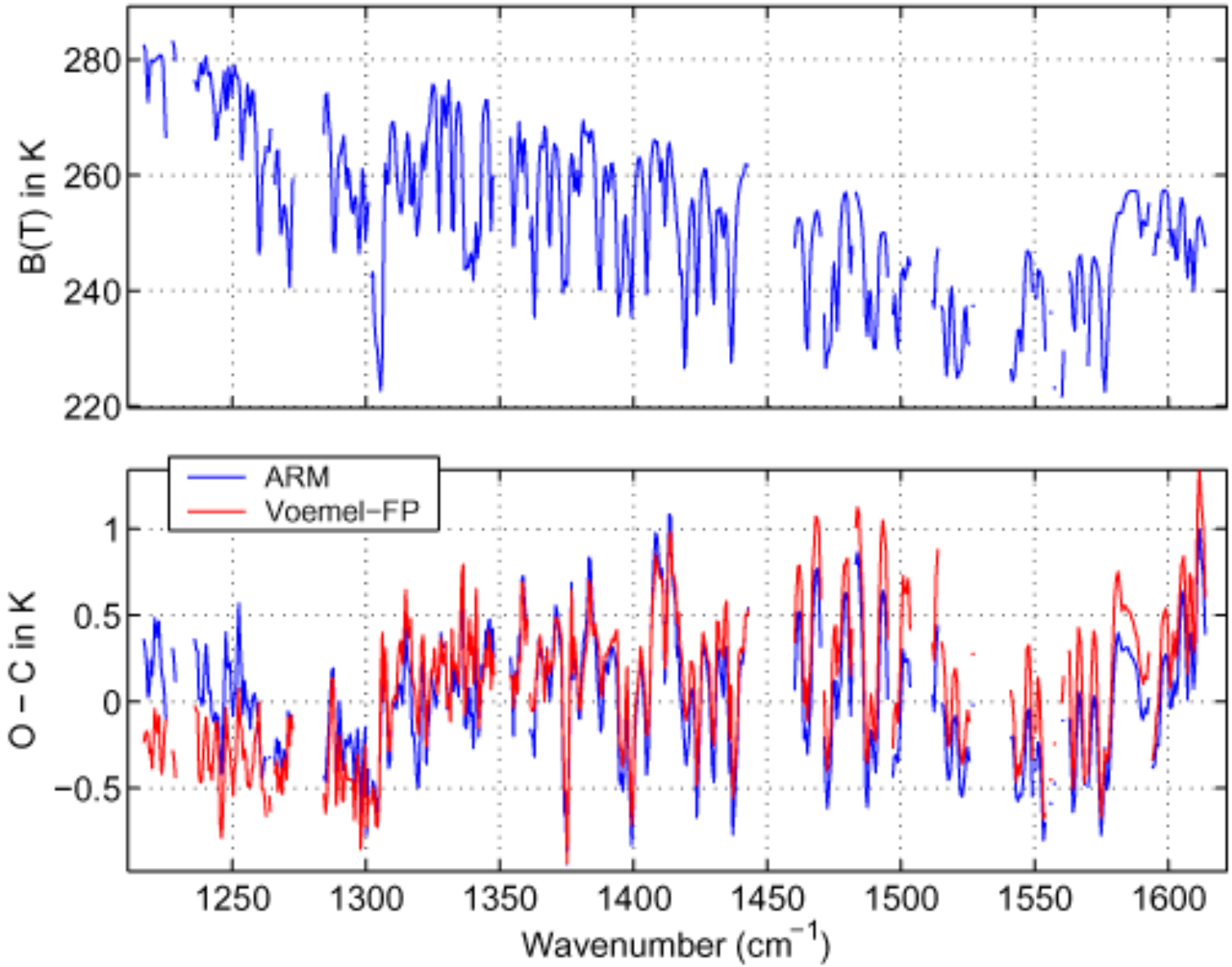
Masuda wspeed = ECMWF



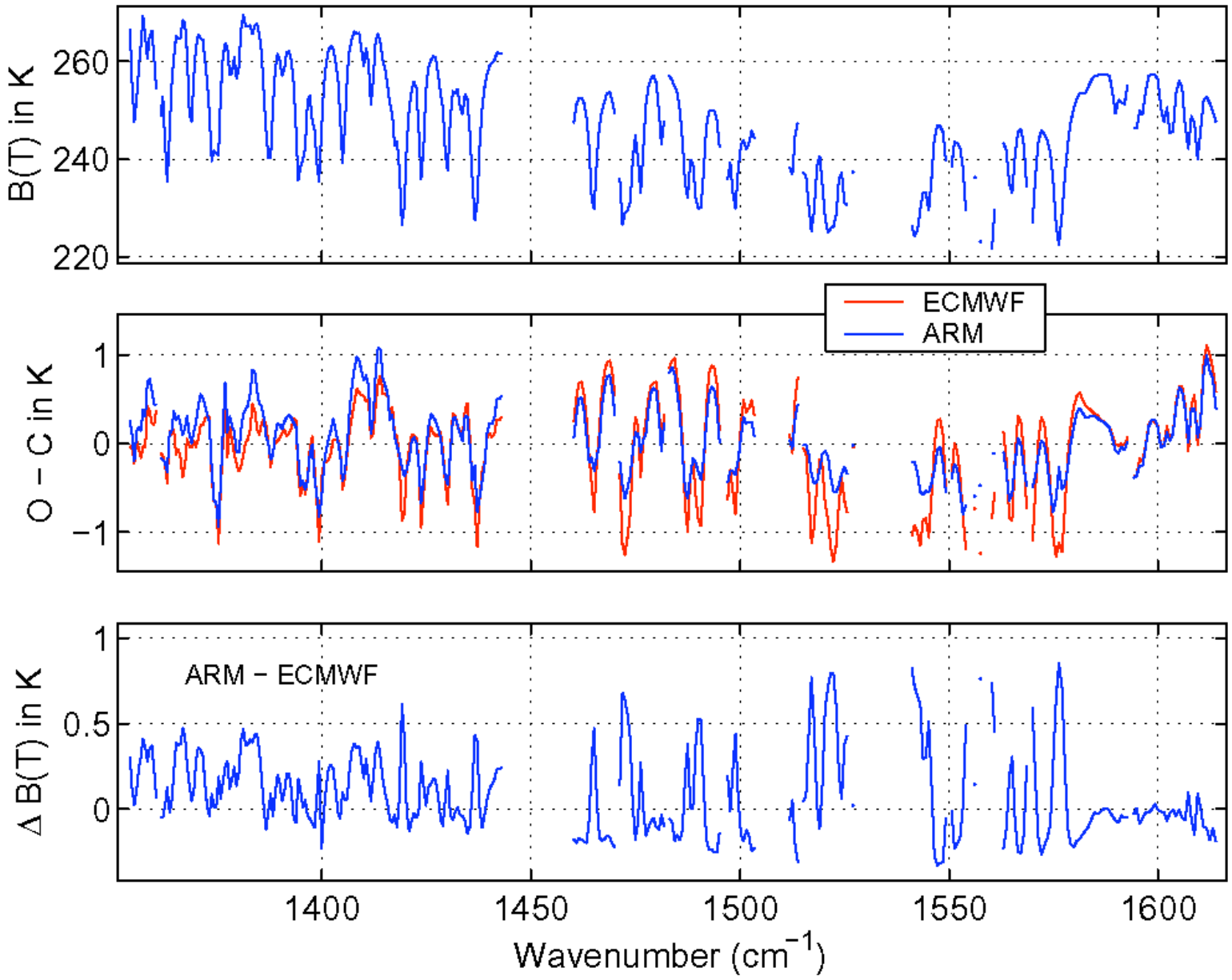


Upper Trop Water RTA Validation Remains

AWEX may help, already have good agreement between
ARM-SGP, Voemel, and ECMWF (between lines)



ARM-SGP vs ECMWF Global Biases in H2O-sounding Channels

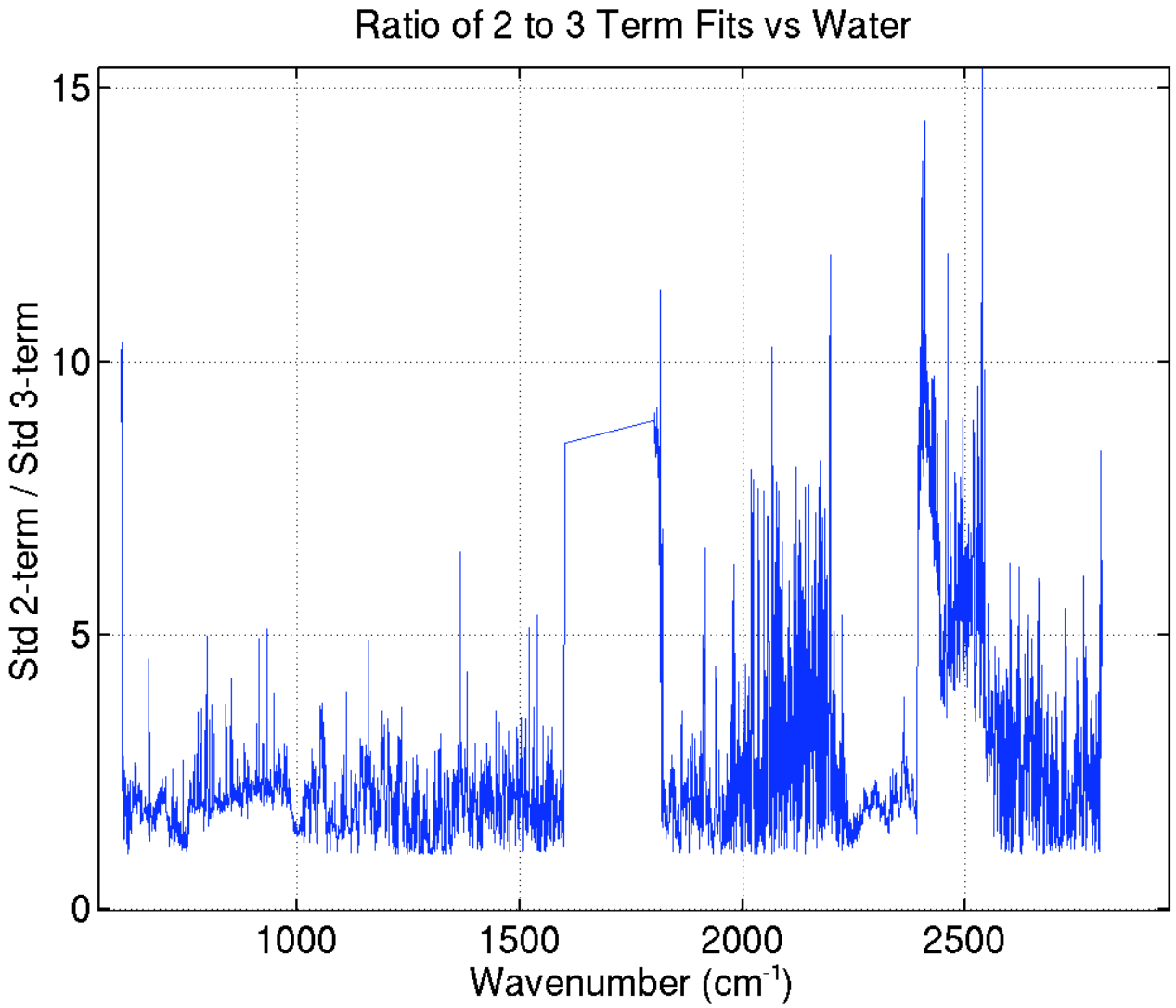
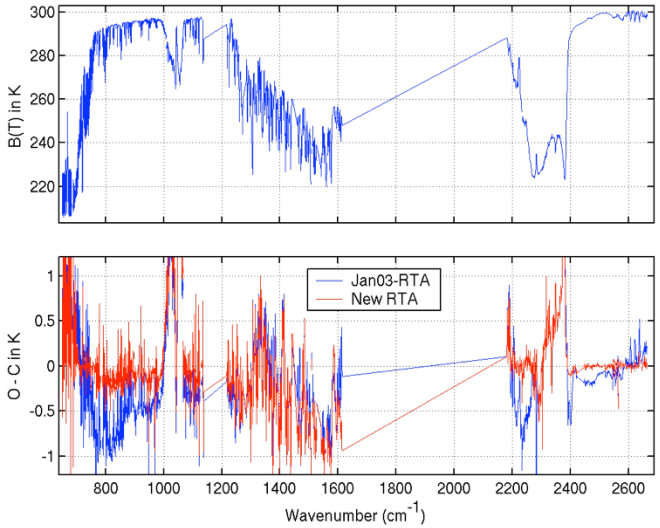
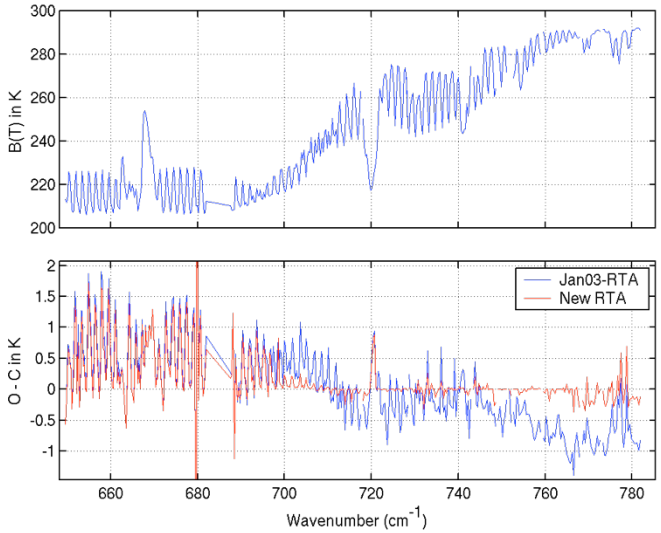
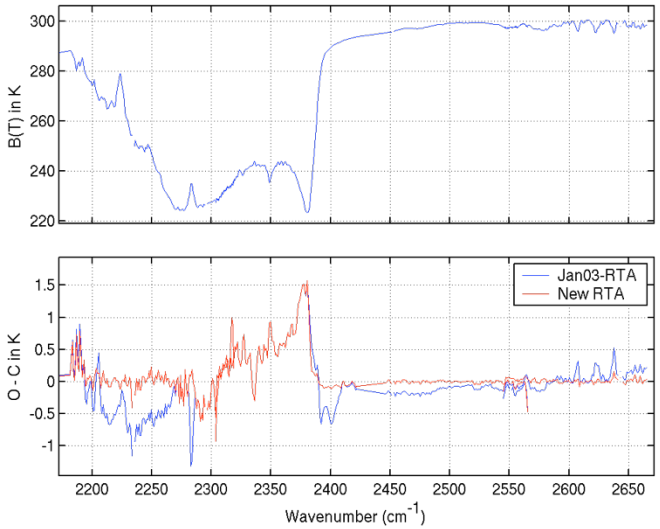
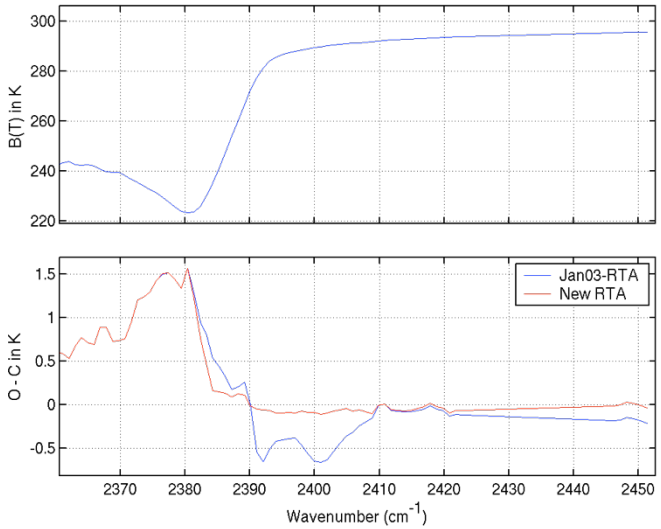


Future Work

- Pick next water continuum:
  - MT_CKD with shortwave mods by UMBC *or*
  - Continuum based on AIRS co-locations with ARM-TWP sondes
  - Both models supplemented with ECMWF in extreme shortwave
  - Test with other months (Oct. 2002 done, very similar to March 2003)
  - Do high continuum values near CO_2 make physical sense? CO_2-H_2O collisions?
- Mid-wave/Upper-trop water. Awaiting ARM-CARL data and AWEX campaign results. Try our new near-wing water lineshape?
- Fixed gas modifications
  - Do RS-90's justify these mods
  - No tuning above ~60 mbar, is ECMWF biases there?
  - Any data around to test these altitudes? Limb sounders?
- Determine source of 2200 cm^{-1} bias, N_2O?

Backup Slides

AERI Fits: Linear Term for CO2-H2O?



Jan03-RTA vs Jan04-RTA